The Numbers Game in Wildlife Conservation

Changeability and framing of large mammal numbers in Zimbabwe

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Thesis

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To my family for their love, support and encouragement

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CHAPTER 1*: General introduction

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Top-down and bottom-up processes are thought to play important roles in the control of large herbivore populations in terrestrial ecosystems (Kay 1998; Grange & Duncan 2006; Banse 2007). However, the strength and role of top-down and bottom-up processes have been reported to vary spatially and temporally (Hunter & Price 1992; Sinclair & Krebs 2002; Meserve et al. 2003; Garrott et al. 2008). Moreover, human activities can potentially affect both top-down and bottom-up processes in terrestrial ecosystems. Humans are a keystone species that can alter terrestrial ecosystem structure and composition through actions such as setting fires and livestock grazing (bottom-up control), and by acting as a generalist super predator, that can top-down harvest any animal species regardless of body mass (Vitousek et al. 1997; Estes et al. 2011). Human activities are, however, influenced by control systems, e.g., policy instruments, incentives and provisions, that help in mitigating impacts of human activities on large herbivore populations (Leeuwis & van den Ban 2004). For example, community-based natural resources programs, such as the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) developed in Zimbabwe, have been implemented to allow for the sustainable use of natural resources in areas bordering protected areas. Most research on the impact of human activities, in particular top-down harvesting, on large herbivore species have focused on tropical rainforests (Brashares et al. 2004; Nasi et al. 2011). Improving our knowledge about the role of natural and human-induced top-down and bottom-up controls in influencing large herbivore populations in savannas is therefore vital. In this thesis, I address these issues while focusing on large herbivore populations in savanna ecosystems.

Population control in ecosystems

The relative importance of top-down and bottom-up processes in the control of both aquatic and terrestrial organisms has been a subject of research and considerable debate among ecologists (Hairston et al. 1960; Kay 1998; Terborgh et al. 2001; Sinclair & Krebs 2002; Banse 2007; Ripple & Beschta 2008; White 2008; Melis et al. 2009; Estes et al. 2011; Hopcraft et al. 2012; Ripple & Beschta 2012). In 1960, Hairston et al. proposed a simple conceptual model for the dynamics of terrestrial communities. They suggested that communities consisted of four groups of organisms (carnivores, herbivores, plants and detritivores), and that their trophic interactions explained why green plants dominate the earth and also why organic biomass does not accumulate. Briefly, Hairston et al. (1960) argued that plants dominate natural communities because carnivores control herbivore abundance, thereby freeing vegetation from herbivore control. Hairston et al. (1960) also suggested that detritivores were resource-limited, thus preventing accumulation of organic matter on a global basis. This simple framework suggested that carnivores and detritivores were limited by competition; that herbivores were controlled by direct predation, and that carnivores indirectly influenced plant abundance. The overall perspective was that ecological communities are controlled by processes whose effect flowed down the food chain; this was later termed top-down control (Hunter & Price 1992).

The alternative view of bottom-up control was the implicit partner of succession theory as developed by plant ecologists (Glenn-Lewin et al. 1992). This perspective held that since plant primary production fueled the animal biota, plants, along with nutrients and light, controlled animal communities from the bottom of the food chain upward to higher trophic levels (White 1978). This perspective was however, not widely accepted by ecologists, perhaps because, in part, plant and animal ecologists interpreted the term ‘control’ differently,

but also because examples could be cited that supported either perspective (Menge 2000). Moreover, in the 1960s, most predator species were wiped out, partly because of dichlorodiphenyltrichloroethane (DDT) use (Wurster 1969; Moriarty 1972; Berny 2007), and many ecologists did not see predators anymore in some ecosystems, and hence, forgot about them and their role in top-down control of large herbivore populations. However, in the 1980s and especially 1990s populations of some species of predators increased in most ecosystems following the ban of DDT use in the late 1980s (Connell et al. 2002).

The current understanding is that both top-down and bottom-up processes influence the size of wild herbivore populations (Sinclair 2003; Grange & Duncan 2006). Their respective strengths vary between different ecosystems, and their relative importance can vary spatially and temporally, with possible abrupt shifts in top-down and bottom-up control occurring over time (Meserve et al. 2003; Sinclair 2003). Abrupt shifts in top-down and bottom-up control may occur in arid and semi-arid ecosystems with strong inter-annual variation in rainfall (Lima et al. 1999; Holmgren et al. 2006). In prevailing dry years, resource-limited conditions lead to strong bottom-up control because of reduced plant productivity, and perhaps reduced seed and insect resources. During wet years, biotic interactions become more important as the abundance of consumers increases and the forces they exert on lower trophic levels become more prominent; consumers have a greater effect on their resources, and top-down control prevails (Meserve et al. 2003).

Top-down population control of large herbivores in terrestrial ecosystems

Predation plays a key role in controlling populations of large herbivores (>5 kg body weight) in tropical ecosystems, especially in non-migratory ecosystems, illuminating one of the features defining the landscape of fear that large ungulates exist within (Sinclair et al. 2003;

Sergio et al. 2008). Top predators may structure a whole community by initiating a trophic cascade (Schmitz et al. 1997; Ripple & Beschta 2004). A trophic cascade occurs when a consumer influences at least two other trophic levels, such as when a predator limits the populations of its prey, which in turn limits the populations of its own prey (Kagata & Ohgushi 2006; Sergio et al. 2008). For example, several North American studies have reported cascades where top carnivores, such as wolf (*Canis lupus*), cougar (*Puma concolor*) or grizzly bear (*Ursus arctos*), affect ungulate density and foraging patterns, with indirect, positive effects on plant species or communities (Peterson 1999; Borer et al. 2005; Fortin et al. 2005; Ripple & Beschta 2008, 2012). Recent evidence, however, suggests that: i) there is little consensus on the occurrence of trophic cascades in terrestrial ecosystems, ii) trophic cascades are quite variable, and iii) trophic cascades are influenced by ecological complexity of the community and anthropogenic influences, thus challenging past findings on the role of large carnivores in ecosystems (Mech 2012).

Moreover, the widespread extinctions of top predators as a result of hunting (pursuing a living thing for food, for sport, or for trade) and persecution by humans and habitat loss have changed terrestrial ecosystem structures through mesopredator release associated with trophic cascades, where increased abundances of medium-sized predators may have detrimental effects on prey communities (Berger et al. 2008; Strong & Frank 2010). For example, populations of red fox (*Vulpes vulpes*), a mesopredator, have increased following the decline of top predators, such as wolves and Eurasian lynx (*Lynx lynx*), due to agricultural expansion in Sweden (Elmhagen & Rushton 2007). The mesocarnivores, small to midsized species (<15 kg) are generally more numerous and diverse than larger carnivores and often reside in closer proximity to humans (Roemer et al. 2009).

Among the African savanna herbivores, Sinclair et al. (2003) have argued that populations of smaller-bodied species are controlled by predation, whereas populations of larger-bodied species (≥150 kg) are limited by forage availability. The relative body size strongly determines: a) relative kill success for particular size classes of prey species, and b) dietary dependency on different body size ranges of prey (Owen-Smith & Mills 2008; Hopcraft et al. 2010). Only above a body mass of around 1,000 kg do mammalian herbivores become generally free of predation, except on immature animals, and hence are almost solely food-limited (Owen-Smith & Mills 2008; Hopcraft et al. 2010).

Bottom-up population control of large herbivores in terrestrial ecosystems

All trophic levels are potentially limited by the availability of food resources (White 1978). Contrary to top-down control, Slobodkin (1960) argued for a bottom-up control that follows the classical laws of thermodynamics, i.e., energy is transferred and converted to potential energy through radiant energy to green plants and finally to a chain of organisms. Therefore, biomass production at all trophic levels is ultimately dependent on the quantity and quality of resources comprising the basal trophic level (Preisser 2007). Thus, changes at the bottom of the food web can have an effect on the entire food web. In most natural communities, densities of large herbivores drop sharply during inclement seasons, e.g., temperate winters, or following major disturbance such as flood, fire, landslide or drought (Power 1992; Garel et al. 2004; Duncan et al. 2012). High rainfall variability is an important factor influencing the population dynamics of large herbivores operating directly on individuals and through its effect on forage characteristics (Illius & O'Connor 1999; Richardson et al. 2005; Hegel et al. 2009). Preisser (2007) suggests that the bottom-up effects of increased productivity at the

basal trophic level may influence the strength of top-down control in a system and the patterns of biomass accumulation at subsequent trophic levels.

Population control in species-poor and species-rich terrestrial ecosystems

The relative importance and strength of top-down and bottom-up controls on mammals′ populations differ between species-poor and species-rich terrestrial ecosystems. Species-poor ecosystems are largely characterized by low secondary productivity (Waide et al. 1999), and predator-prey systems with only one major predator and a few prey species, such as in temperate woodlands and tundra (Mittelbach et al. 2001). In these ecosystems, it is suggested that bottom-up control of prey is dominant, with a few exceptions of top-down control of prey (Sinclair 2003). Although population control of prey by their predators, for instance, in North America and Canada may result in regular periodic fluctuation in population size (cycles), bottom-up processes are still key to those fluctuations (Roth et al. 2007). However, recent evidence suggests less strong small herbivore cycles associated with a reduction in winter population growth across Europe, although the role of bottom-up processes responsible for cyclicity have not been lost (Cornulier et al. 2013).

Species-rich ecosystems or high diversity systems of large mammal herbivores and carnivores are mostly associated with tropical savannas (Olff et al. 2002). In species-rich ecosystems large predators exploit a wider range of prey sizes, very large herbivores being less affected by predation (Radloff & Du Toit 2004; Dobson 2009) and smaller ungulates having many more predators than larger ungulates. Thus, smaller ungulates experience more predation and are potentially predator controlled whereas large herbivores (≥150 kg) are mostly bottom-up controlled (Sinclair 2003; Hopcraft et al. 2010; Fritz et al. 2011).

The human factor on top-down and bottom-up control in animal communities

Top-down control: human influence

Recent studies suggest that humans precipitated the recent local extinction of large carnivores and herbivores in many parts of the globe through combined direct (hunting) and perhaps indirect impacts, for example, competition, habitat alteration and fragmentation (Barnosky et al. 2004; Surovell et al. 2005; Koch & Barnosky 2006; Beschta & Ripple 2009). On continents worldwide, about 90 genera of mammals weighing ≥44 kg have disappeared (Koch & Barnosky 2006). Under the overkill hypothesis, extinction occurs because hunting causes death rates to exceed birth rates in prey species (Martin 1966). It has been suggested that anthropogenic factors such as the selective hunting of large mammals by recently arrived humans played an important role in the extinction of the megafauna in North America, South America and perhaps other landmasses, compared to the minor role that changes in climate and vegetation played at the end of the Pleistocene (Martin 1966; Kay 1994; Barnosky et al. 2004; Lyons et al. 2004; Rule et al. 2012).

Human hunting, therefore, merely adds to the cumulative number of deaths by some critical amount and the extinction could be sudden or gradual. Hunting in most countries is subject to rules and regulations that hunters must abide by, and any violation against any of these rules and regulations causes the act to be considered as poaching or illegal hunting and is punishable by law. The extent of human hunting impacts on large herbivore populations in terrestrial ecosystems varies with rainfall, secondary productivity, abundance and diversity of large herbivores in biomes (Fig. 1). Species that have slow life histories (Jeschke & Kokko 2009), for example, most large bodied herbivores, would be more susceptible to extinction under any environmental or anthropogenic impact that targeted slow breeders (Koch & Barnosky 2006). For example, in much of tropical forest ecosystems in Africa and Latin

America, populations of many large bodied wildlife species have already declined or were extirpated because of habitat loss and hunting, leaving a fauna predominantly characterised by fast life histories, i.e., small-bodied and rapidly reproducing species (Bennett et al. 2007; Van der Hoeven 2007; Fa & Brown 2009; Mbete et al. 2011; Nasi et al. 2011; Wilkie et al. 2011; Canale et al. 2012).

Across much of the globe, humans have reduced the range of large carnivores through widespread poisoning, trapping and hunting (Laliberté & Ripple 2004; Tveraa et al. 2007). In addition, the loss of top predators due to human persecution alters trophic cascades, which may lead to habitat degradation, species loss and even ecosystem collapse (Berger et al. 2001; Ripple et al. 2010; Estes et al. 2011). Human-introduced diseases have also altered the natural top-down controls through death of some large carnivores. For example, following the introduction of canine parvovirus in Isle Royale, United States of America, wolf populations declined, resulting in a switch from top-down to bottom-up control of the moose (*Alces alces*) population (Wilmers et al. 2006). Similarly, the lion (*Panthera leo*) population in Ngorongoro Crater, Tanzania, has become unusually vulnerable to infectious disease in recent years owing to its close proximity to a growing human population, thus, altering the strength of the top-down control in the ecosystem (Kissui & Packer 2004).

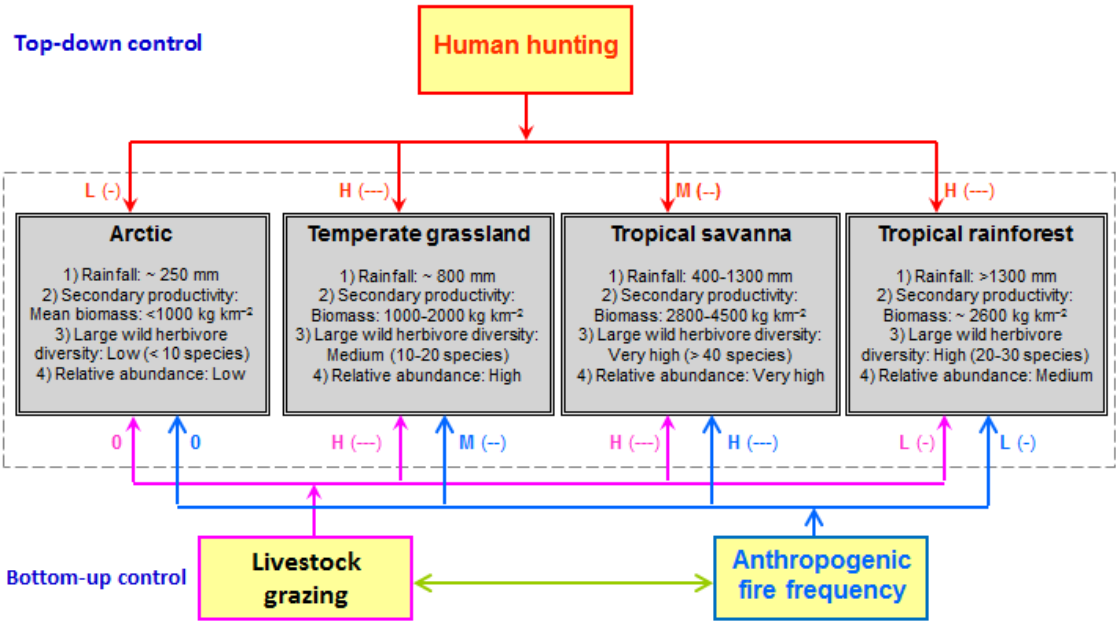

Fig. 1. A schematic representation indicating the top-down and bottom-up controls of human activities (at global biome level) particularly on wild large herbivore community in the arctic, temperate grasslands, tropical savannas and tropical rainforests. Data sources: Barnes and Lahm (1997), Du Toit and Cumming (1999) and Sala et al. (2001). *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.

Bottom-up control: human influence

Vegetation fires

Besides biotic interactions, external factors such as fire are also considered to be important determinants in shaping large herbivore assemblages. Vegetation fires are a common and predictable feature of the world's grasslands, savannas, Mediterranean shrublands and boreal forests (Bond et al. 2005; Russell-Smith et al. 2012). The extent of fires and their impacts in

an ecosystem is largely determined by rainfall and its interaction with herbivory and human activities (Fig. 1). Despite the important ecosystem role played by fire, human activities have altered natural fire regimes relative to their historic range of variability (Eriksen 2007; Syphard et al. 2007), affecting both the primary production of ecosystems and, the strength of bottom-up controls of large herbivores.

Moreover, fire may cause nitrogen loss and affects net primary productivity in ecosystems, particularly in the savannas (Bond 2008). Recent studies suggest that fires do exert a bottom-up control on large mammal communities. For example, Klop and van Goethem (2008) suggest that the response of herbivore communities to fire is likely to be the compound effect of various factors, including changes in habitat structure, resource selection patterns, predator avoidance and biotic interactions such as competition. In addition, the effects of fire on ungulate community structure may depend on the time of burning in the season, the extent of burning and the availability of other high-quality grass swards on, for example, grazing lawns and floodplains. Thus, during the dry season and on a local scale, savanna fires are a major factor governing ungulate community structure (Klop & van Goethem 2008). Further, Klop and Prins (2008) concluded that species richness and assemblage composition of grazers in African savannas are largely governed by anthropogenic fires that modify the quality and structure of the grass sward.

Livestock rearing

With domestication of animals, agriculture brought about a major shift in the interactions between humans and their surroundings (Fig. 1). Herds of domestic animals, often composed of single species, have replaced more diverse indigenous herbivore communities over very large areas (Cumming & Cumming 2003). Previous studies suggest that livestock grazing

may cause a significant reduction in the standing crop of forage, and that high diet overlap between livestock and wild herbivores, together with density-dependent forage limitation, may result in resource competition and decline in wild herbivore populations especially in Africa and Asia (Prins 1992, 2000; Madhusudan 2004; Georgiadis et al. 2007; Dave & Jhala 2011; Bhola et al. 2012).

Natural resources management systems

The increasing pressure on native animal populations expanding human and livestock populations, and settlements, have resulted in native large herbivore species and their habitats being conserved within a few types of land property regimes: state (or public), private, and communal (Naughton-Treves & Sanderson 1995). The conservation and management of native large herbivore species and their habitats also occurs in various mixed types and models in different areas, largely determined by varying institutional types and systems, as well as different forms of governance models. Protected areas are places where major threats can somehow be managed and are the most important tool for biodiversity conservation throughout the world, as well as providing economic and cultural benefits (Naughton-Treves et al. 2005; Gaston et al. 2008). Protected areas include national parks and biological reserves, and mostly encompass diverse animal species (Bennett et al. 2007). Private wildlife management areas include game farms and conservancies (McGranahan 2008; Lindsey et al. 2009b).

Community-based conservation initiatives have been implemented in some wildlife areas in order to reduce unsustainable exploitation of wildlife and human-wildlife conflicts, whilst also providing local communities with conservation benefits or incentives (Prins et al. 2000; Holmern et al. 2007; Mwakiwa 2011). For instance, the Communal Areas Management

Programme for Indigenous Resources (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 adjacent to state protected areas (Martin 1986; Child 1993, 2000; Child & Chitsike 2000). Under CAMPFIRE, local communities realise financial benefits from the management of local natural resources including wildlife (Mapedza 2009; Fischer et al. 2011). However, presently there is little evidence that community-based conservation programs have reduced or even stabilized the amount of illegal activity or human-wildlife conflicts, primarily because these programs fail to offer sufficient incentives for local communities to stop utilizing wildlife illegally, and also fail to reduce costs of conflicts with wildlife (Barrett & Arcese 1995; Algotsson 2006; Johannesen 2006; Winkler 2011). 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.

Control systems on human activities in natural resources management

Man's interactions with nature are based on a mix of slowly developed social norms and expectations, and increasingly on more rapidly developed short-term incentives and controls (Holling & Meffe 2002). Control is a deeply entrenched aspect of contemporary human societies, i.e., human behavior is controlled through laws, incentives, threats, contracts, and agreements (Holling & Meffe 2002). Control systems are defined here as the formal and informal rules, regulations, laws, social values and belief systems (or dominant beliefs) that orient and influence human behaviour in general (including hunting, grazing, using fire among others). In wildlife areas, policy instruments are designed to change human behaviour in order to minimise its impacts on natural resources. Rowcliffe et al. (2004) suggest that

since hunters will not comply voluntarily, the protection of vulnerable species can only take place through effective enforcement, for example, by wildlife authorities restricting access to protected areas, or by traditional authorities restricting the sale of protected species in local markets. This suggests that law enforcement is crucial in curbing unsustainable and illegal exploitation of animal populations (Holmern et al. 2007; Keane et al. 2008; Knapp 2012).

Leeuwis and van den Ban (2004) outline an instrumental model of policy intervention characterized by two important and interrelated features which can be important in understanding human behavior changes. The first feature is that policy intervention take place after the goals and corresponding policies have been defined, in order to persuade as many people as possible to accept a given policy. The second feature is that communication is used deliberately as a policy instrument (in conjunction with other instruments) in order to steer and direct human behaviour, which is thought to be largely predictable (Leeuwis & van den Ban 2004, also refer to the 'sorting scheme' in Fig. 2). From Fig. 2, a distinction is made between 'non-voluntary' (or 'compulsory') and 'voluntary' behaviour.

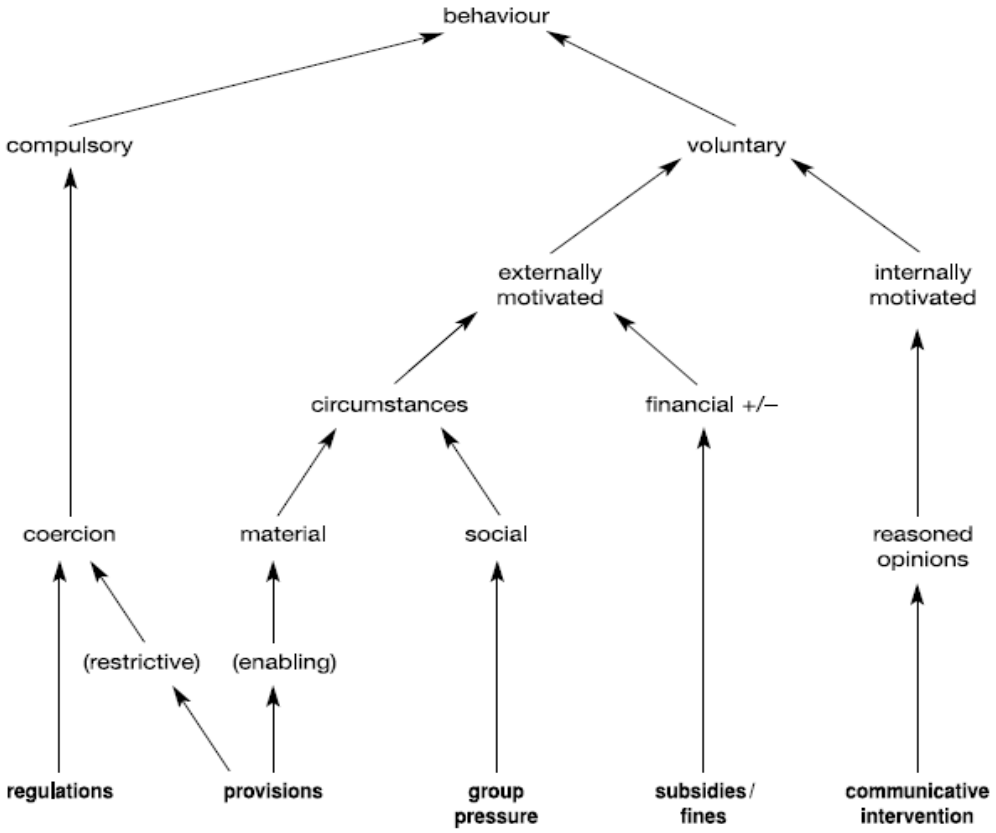

Fig. 2. The relationship between communicative intervention and other policy instruments aimed at stimulating human behavioural change, for example, human activities that affect large herbivore populations. Policy instruments are indicated in bold. *Source*: Leeuwis and van den Ban (2004).

Compulsory behaviour arises from coercion (top-down enforcement) that derives from laws and regulations or constraints caused by restrictive provisions (e.g., a game fence) (Leeuwis & van den Ban 2004). For example, hunters may be restricted by punishments, from fines and prison terms to social sanctioning, depending on the enforcement system (Keane et al. 2008). On the other hand, voluntary behaviour can either be internally or externally motivated (Leeuwis & van den Ban 2004). Externally motivated voluntary behaviour

originates from material and social circumstances or financial impulses (e.g., group pressure, provisions and financial (dis)incentives, including income generation from tourism ventures and selling of local products to visitors) brought by the corresponding policy instruments. Internally motivated voluntary behaviour may arise from reasoned opinions (e.g., a conviction that bushmeat hunting or setting unprescribed veld fires is not proper) that can be influenced by communicative intervention (Leeuwis & van den Ban 2004), for example, through awareness or educational programmes (De Boer et al. 2013).

Media framing of wildlife conservation

In the African context, societal decisions about wildlife management, control systems and policy instruments are negotiated between international donors, politicians and governments. Such decisions are not only informed by scientific information, but may also be shaped by image formation and public opinion. The media are a principal arena within which wildlife conservation issues come to the attention of decision makers, interest groups and the public (Goulding & Roper 2002; Barua 2010) and can both reflect and reinforce existing images of wildlife conservation. Wildlife conservation has been a public issue since time immemorial, and a cause of increasing concern over the course of the 20th century (Naughton-Treves & Sanderson 1995). Since societal decisions about wildlife management are not only taken on the basis of scientific information, hence it's important to better understand the role of mass media in framing wildlife conservation in changing environments.

Conservation of the wildlife resources is complicated by the growing human populations and high poverty levels in most nations, the high densities of humans living in and/or adjacent to some protected areas, social and environmental human displacement, civil unrest, the uncontrolled and increasing trade in wildlife and plant products that feeds urban as

well as international markets, and the process of globalization (Newmark 2008). Consequently, the media plays an important role, particularly, in wildlife conservation following disasters and political conflict among other crises (Tierney et al. 2006). Framing is used in studies of the media and mass communication as a tool of analysis in order to find how issues and discourse are constructed, and meanings developed (Goffman 1974; Entman 1993; Reese 2007). It is this ability of the media through their use of frames to tell people how to think about something that makes the study of frames useful (Ray 2004), in wildlife conservation, especially in times of disasters and/or political conflict which may lead to increased illegal hunting and resource exploitation and collapse of wildlife management systems.

Research objective and questions

The main objective of my study is to generate information that would 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. Moreover, I investigate framing of wildlife conservation in the mass media following a political crisis and economic decline. My objectives were guided by the following four specific research questions:

I) How does rainfall influence large herbivore populations in a semi-arid savanna ecosystem?

II) What is the impact of illegal hunting on large herbivore populations and what is the relationship between illegal hunting and law enforcement in a semi-arid savanna ecosystem?

III) Is there a relationship between the extent of human-wildlife conflicts and effectiveness of community-based wildlife conservation programs, and what factors influence the effectiveness of community-based wildlife conservation programs?

IV) How are issues on wildlife conservation framed in the mass media and does framing of wildlife issues change following a country's political crisis and economic decline?

In this thesis, I aimed to fill some of the gaps in knowledge, particularly the roles of natural and human-induced top-down and bottom-up controls of large herbivore populations in savanna ecosystems, by adopting an interdisciplinary approach, and employing methodologies from both biological and social sciences. Interdisciplinary approaches have been used satisfactorily in conservation related studies before (Dickman 2010; Kent 2011). I zoomed into a local level savanna ecosystem and I focused on Zimbabwe, with field-based data being collected from Gonarezhou National Park and adjacent areas. Zimbabwe experienced a political crisis and economic collapse starting in 2000 following the country's land reforms.

Outline of the thesis

This thesis consists of six chapters, including this general introduction (Chapter 1), four chapters in which original research is presented (Chapters 2–5) and the synthesis (Chapter 6). In Chapter 2, I analyse the influence of rainfall on wild large herbivore populations in a semi-arid savanna ecosystem based on rainfall from five adjacent areas (namely, Gonarezhou National Park, Malilangwe Wildlife Reserve, Save Valley Conservancy, Buffalo Range Airport in Zimbabwe and Kruger National Park, South Africa, which relates to question one of this thesis) and aerial survey data for large herbivores from Gonarezhou National Park and

Kruger National Park. Rainfall data between 1970 and 2009 were used to determine synchrony in wet and drought occurrence among the five study sites. Differences in mean rainfall across the five sites were determined using one-way analysis of variance. A B-spline modeling approach (Eilers & Marx 1996) with a break-point related to the 1992 severe drought was used to analyse trends of large herbivore populations in Gonarezhou between 1984 and 2004. Moreover, simple linear regression models were used to establish the relationship between rainfall and large herbivore populations.

In Chapter 3, I analyse illegal hunting and law enforcement dynamics following the economic decline in Zimbabwe using a case study of Gonarezhou National Park, which relates to the second research question of this thesis. Data on illegal hunting and law enforcement between 2000 and 2010 were collected from the park's database. Moreover, I interviewed 236 local people on their knowledge and perceptions of illegal hunting and law enforcement from four communities adjacent to the northern Gonarezhou National Park. Chi-square (χ^2) tests were used to determine differences among responses on perceptions and knowledge of illegal hunting and law enforcement from the respondents and across communities. Trends in illegal hunting dynamics and law enforcement were analysed using *t*-tests whereas repeated measures analysis of variance was used to determine the overall effect of law enforcement activities on illegal hunting between 2000 and 2010.

In Chapter 4, I investigate the relationship between the effectiveness of community-based conservation programs and extent of human-wildlife conflicts in local communities adjacent to the northern Gonarezhou National Park, Zimbabwe, relating to question three of this thesis. Data on perceived effectiveness of CAMPFIRE and human-wildlife conflicts were collected from interviews with 236 local people and focus group discussions. Moreover, I collected data on incidences of human-wildlife conflicts and revenue received by the local

communities from CAMPFIRE between 2000 and 2010. Correlation analysis was used to determine the relationship between CAMPFIRE effectiveness and perceptions of human-wildlife conflicts. Kruskal-Wallis and chi-square (χ^2) homogeneity tests were used to analyse the differences between communities and respondents' perceptions on CAMPFIRE effectiveness and human-wildlife conflicts. Regression analysis was used to determine the trends of recorded human wildlife communities in the study communities between 2000 and 2010.

In Chapter 5, I analyse media framing of wildlife conservation in Zimbabwe, between 1989 and 2010, relating to question four of this thesis. Data on elephant population, rhino population, rhino poaching and CAMPFIRE revenue were collected and analysed. Regression analyses were used to determine trends of elephant and rhino populations. *T*-tests were used in analysing differences in rhino populations before and after the 2000 land reform in Zimbabwe, and also to establish differences between rhino population performances between Zimbabwe and South Africa. Moreover, only newspaper articles focusing on wildlife conservation in Zimbabwe published in seven newspapers from the United Kingdom, United States of America and Zimbabwe were considered. Entman's (1993, 2004) frame analysis approach was used.

In the last chapter, Chapter 6, I integrate and synthesize the main findings within the theoretical framework. I have attempted in this chapter to place the findings of this study in the broader context of population controls in terrestrial ecosystems, with particular interest to the savanna ecosystems. Lastly, I also discuss the scientific, societal and management implications of the findings of this thesis.

CHAPTER 2: Bottom-up forcing on large herbivore population dynamics in a semi-arid African savanna*

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* *This Chapter is submitted as:*

Gandiwa, E., Heitkönig, I.M.A., Eilers, P.H.C. and Prins, H.H.T. Bottom-up forcing on large herbivore population dynamics in a semi-arid African savanna.

Abstract

Large herbivore populations are influenced by bottom-up processes. Bottom-up processes include resource control or limitation driven factors such as rainfall and nutrients. In arid and semi-arid environments, extreme events such as droughts also influence animal populations. We investigated the rainfall patterns and fluctuations of nine common wild large herbivore species in Gonarezhou National Park, southeast Zimbabwe. We predicted that: i) there is a synchrony in rainfall and drought occurrence within the same region, i.e., areas occurring close to each other, and ii) large herbivore populations decline following droughts. Our results showed that between 1970 and 2009, Gonarezhou recorded three wet years (1977, 1978 and 2000) and six drought years (1973, 1983, 1989, 1992, 1994 and 2005). However, there were some variations in the drought occurrences between Gonarezhou and adjacent areas indicating a weak synchrony in rainfall patterns. Furthermore, seven large herbivore species showed dips in their populations associated with the 1992 severe drought, with most of the species' populations recovering thereafter. Overall, rainfall (annual and for lag periods of 1 to 9 years) appeared not to significantly influence large herbivore abundances in Gonarezhou. Our results, therefore, partly support both study predictions. Our findings underscore the need for further detailed studies on bottom-up processes influencing large herbivore population trends in savanna ecosystems with high rainfall variability.

Keywords: annual rainfall, bottom-up process, conservation, drought, savanna

Introduction

African savannas harbour a high diversity of large herbivore species (Prins & Olff 1998; Du Toit & Cumming 1999), which have important ecological as well as economic value (Prins et al. 2000; Olff et al. 2002; Gordon et al. 2004). The decline in large herbivore abundances in Africa has received considerable recent attention (Scholte et al. 2007; Craigie et al. 2010; Ogutu et al. 2011a; Bouché et al. 2012). Bottom-up processes are thought to influence the abundance of animal populations (Hairston et al. 1960). Bottom-up processes include competition for forage resources which may be determined by rainfall amongst other forces (Kay 1998; Meserve et al. 2003; Grange & Duncan 2006; Elmhagen & Rushton 2007; Turkington 2009; Pierce et al. 2012). The discussion of bottom-up processes in the regulation of mammalian herbivore populations has been prominent in ecology for over 50 years (e.g., MacArthur 1955; Smuts 1978) and remains an important research topic today (Ogutu & Owen-Smith 2005; Grange & Duncan 2006; Hopcraft et al. 2010; Fritz et al. 2011).

According to a review by Saether (1997), population changes of large herbivores in predator-free environments are strongly influenced by a combination of variations in the environment and population density. Fluctuations in population size can be caused by climatic variation influencing resource availability (Owen-Smith 1990; Saether 1997; Illius & O'Connor 2000; Valeix et al. 2008). Rainfall is a central climatic factor governing population dynamics in African savannas (Prins & Olff 1998; Ogutu & Owen-Smith 2005; Ogutu et al. 2008) through its influence on primary production, particularly in semi-arid areas (Coe et al. 1976; Hilborn & Sinclair 1979; East 1984; Prins 1988; Mduma et al. 2001; Owen-Smith & Ogutu 2003; Duncan et al. 2012). Therefore, the population performance of African large herbivores decline during droughts because of reduced vegetation production and quality (Owen-Smith 1990; Illius & O'Connor 2000; Voeten et al. 2009; Ogutu et al. 2011b).

Arid and semi-arid ecosystems have highly variable rainfall and frequent droughts, where herbivore populations vary markedly (Boone & Wang 2007; Chamaille-Jammes et al. 2007). Ellis and Swift (1988) recorded large variations in livestock numbers in response to low and extremely variable rainfall in northern Kenya, although they emphasized that the system was persistent. Ellis and Swift (1988) hypothesized a non-equilibrium system in which livestock populations increased during years of ample rainfall, then crashed during droughts, with populations at other times rarely becoming high enough to be limited by primary production, or in turn to have significant effects upon vegetation. Vegetation and livestock dynamics were only weakly linked, competition for forage was low, and the system was dominated by abiotic factors (Boone & Wang 2007). In contrast, equilibrium systems are thought to be driven by the important role of biotic feedbacks such as density-dependent regulation of animal populations and the feedback of animal density on vegetation composition, cover and productivity, with resultant range management under this system focusing on carrying capacity, stocking rates and range condition assessment (Vetter 2005).

Weak or non-synchronicity of droughts have been reported to occur in some regions (Vicente-Serrano & Cuadrat-Prats 2007), primarily as a result of geographic diversity and different atmospheric patterns. Moreover, previous studies considering multiple species assemblages of large herbivores in African savannas have generally shown that large herbivore populations are variably influenced by rainfall, with large grazers being more negatively affected than large browsers following droughts (Drent & Prins 1987; Prins & Douglas-Hamilton 1990; Owen-Smith & Ogutu 2003; Owen-Smith & Mills 2006; Ogutu et al. 2008; Shrader et al. 2010; Ogutu et al. 2012).

In this study, we considered the influence of variable rainfall, a bottom-up process, on wild large herbivore populations in the semi-arid Gonarezhou National Park (hereafter,

Gonarezhou), southeast Zimbabwe and adjacent areas which forms the study region. We define the study region as constituting a geographical extent of ~700 km long and ~50 km wide. We test the following predictions: i) that there is a synchrony in rainfall and drought occurrence within the same region, and ii) that large herbivore populations decline following droughts. We expected that: i) there are similarities in mean rainfall and drought occurrence in areas within the same region and ii) large herbivore populations show dips with decreasing rainfall especially during droughts, followed by upswings thereafter. Moreover, we expected the grazers to suffer more than the browsers because grass production is likely to suffer more than the woody leaf production. In addition, we expected the large grazers to suffer more than the small grazers, because the drought causes a low grass production where small grazers can still get some green leaves from in-between places, but large grazers won't get enough bulk food.

Methods

Study areas

We considered five study areas: Gonarezhou, Buffalo Range Airport, Malilangwe Wildlife Reserve, Save Valley Conservancy in Zimbabwe and Kruger National Park (hereafter, Kruger), South Africa. From those areas we collected data on annual rainfall between 1970 and 2009. Moreover, we only collected data on large herbivore populations between 1984 and 2009 from Gonarezhou and Kruger since these were the wildlife areas with large herbivore population data before and after the 1992 severe drought. Detailed descriptions: Gonarezhou National Park is a state protected area that was established in 1975 according to the *Parks and Wildlife Act* of 1975. Gonarezhou has been part of the Great Limpopo Transfrontier Park since 2000. Covering an area of ~5050 km^2, Gonarezhou is located in the southeast lowveld

of Zimbabwe, between 21° 00'–22° 15' S and 30° 15'–32° 30' E and is the country's second biggest protected area. Gonarezhou has an altitudinal range of between 165 and 575 m above mean sea level and shares over 100 km border with Mozambique to the east. On the Mozambiquean side adjacent to the Gonarezhou, the predominant land-use is wildlife conservation and the area consists of landscapes that are generally flat with similar vegetation to that of Gonarezhou. Gonarezhou also borders the fenced Malilangwe Wildlife Reserve in the northwest (Fig. 1), and communal lands in the north, south and west. Gonarezhou is not entirely fenced with the exception of the northern border with Malilangwe Wildlife Reserve and adjacent communal areas for a distance of ~80 km.

Malilangwe Wildlife Reserve (20° 58′–21° 15′ S, 31° 47′–32° 01′ E) covers ~400 km^2 and borders the northern Gonarezhou with an altitudinal range of between 300 and 510 m above sea level. The reserve was established in 1994 with the primary land use being ecotourism (Traill & Bigalke 2007; Clegg & O'Connor 2012). Save Valley Conservancy (20° 05' S, 32°00' E) covers ~3400 km^2 and is located north of Malilangwe Wildlife Reserve with an altitudinal range of between 480 and 620 m above sea level. The conservancy which is a cooperatively managed wildlife area was established in 1992 with ecotourism being the primary land use (Lindsey et al. 2011b; Williams 2011). Buffalo Range Airport (21° 00' S, 31° 34' E) has an altitude of ~430 m above sea level and is located close to the three wildlife areas in Zimbabwe (Fig. 1). The Kruger National Park (22° 25′–25°32′ S, 30° 50′–32° 2′ E) is situated in north-eastern South Africa and covers ~20000 km^2 with an altitudinal range of between 260 and 840 m above sea level. The park was established in 1926 (Kennedy et al. 2003; Seydack et al. 2012). Malilangwe Wildlife Reserve, Save Valley Conservancy and Kruger are largely fenced, but this does not stop the movement of some animal species.

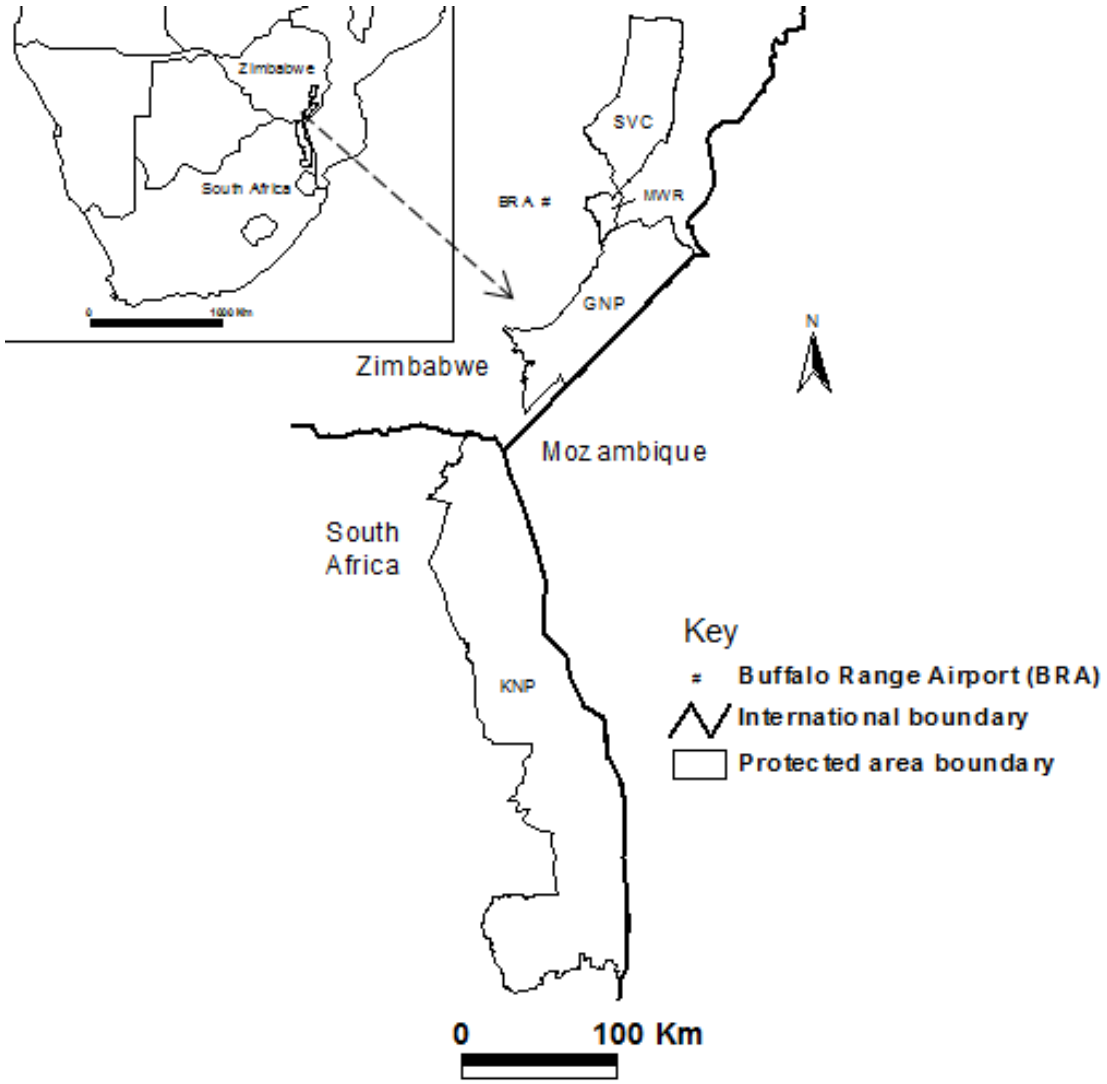


Fig. 1. Location of Gonarezhou National Park (GNP) and adjacent protected areas: Malilangwe Wildlife Reserve (MWR), Save Valley Conservancy (SVC) and Buffalo Range Airport (BRA) in Zimbabwe and Kruger National Park (KNP) in South Africa which forms the study region. *Notes*: The study region is ~700 km long and ~50 km wide, i.e., North–South "transect" and falls within the "same" rainfall zone. It gets wetter towards the north-east and south-east (FAO 2004).

Three seasons can be distinguished for the five areas: hot and wet (November to March), cool and dry (April to August), and hot and dry (September to October). The study area is characterised by highly variable rainfall and is prone to frequent droughts (Poshiwa et al. 2013). The habitats contained in the study areas are arid and semi-arid deciduous African savanna with *Colophospermum mopane* woodland being a common vegetation type (Clegg & O'Connor 2012; Cunliffe et al. 2012; Seydack et al. 2012). There is a wide variety of wild large herbivore species in Gonarezhou, Malilangwe Wildlife Reserve, Save Valley Conservancy and Kruger, and these include buffalo (*Syncerus caffer*), elephant (*Loxodonta africana*), wildebeest (*Connochaetes taurinus*), zebra (*Equus quagga*), eland (*Taurotragus oryx*), kudu (*Tragelaphus strepsiceros*), giraffe (*Giraffa camelopardalis*), impala (*Aepyceros melampus*), nyala (*Tragelaphus angasii*), roan antelope (*Hippotragus equinus*), sable (*Hippotragus niger*), waterbuck (*Kobus ellipsiprymnus*) and warthog (*Phacochoerus aethiopicus*).

Data collection

Rainfall

Monthly rainfall data for the period 1970 to 2009, from five areas, namely, Gonarezhou, Buffalo Range Airport, Malilangwe Wildlife Reserve, Save Valley Conservancy and Kruger were collected from the properties' management and South African National Parks.

Animal data

Data on long-term population sizes of wild large herbivores in Gonarezhou were obtained from the then Department of National Parks and Wildlife Management, now known as Zimbabwe Parks and Wildlife Management Authority as were aerial survey reports (Table 1).

We focused on the period 1984 to 2009 since multispecies aerial surveys in Gonarezhou only commenced in 1984. All past aerial surveys in Gonarezhou used the repeated systematic reconnaissance flight method (Norton-Griffiths 1978). Aerial census procedures have been described fully elsewhere (Norton-Griffiths 1978; Ottichilo et al. 2001). Briefly, in Gonarezhou, 12 aerial surveys were conducted between 1984 and 2009 and these surveys had a mean sampling intensity (i.e., area covered with strips) of 13%, and were mostly conducted in the dry season between August and September. In most of the aerial surveys, Cessna 182, 185, or Cessna 210J centurion aircrafts were used and fitted with a radar altimeter. The population estimates for each species and their 95% confidence intervals for every census were calculated using the Jolly's No. 2 method for unequal size sample units (Jolly 1969).

We also collected available data on large herbivore population estimates in Kruger for the period 1984 and 2006 from published articles (Van Aarde et al. 1999; Ogutu & Owen-Smith 2003; Young et al. 2009; Seydack et al. 2012). In Kruger, population counts for large herbivores throughout the entire park were undertaken annually between 1980 and 1993 using fixed-wing aircraft which comprised of a pilot, a recorder and four observers. Surveys were flown between May and August when visibility was best. However, after 1998 surveys were conducted at relatively low sampling intensities using the distance sampling method. Moreover, buffalo and elephant counts in Kruger have been conducted separately using a helicopter to split herds into smaller groups which were then photographed with animals on the photographs being later counted with visual aids (Owen-Smith et al. 2012; Seydack et al. 2012). More details about aerial surveys in Kruger are provided by Viljoen (1996).

Table 1. Background information on large herbivore aerial surveys in Gonarezhou National Park, southeast Zimbabwe, between 1984 and 2009.

Year	Survey period	Sampling intensity (%)	Source
1984	September	11	Sharp (1984)
1986	August	17	Sharp (1986)
1987	May	10	Sharp (1987)
1989	August–October	10	Gibson (1989)
1991	September	10	Jones (1991)
1993	September	14	Bowler (1993)
1995	July–November	11	Davies et al. (1995)
1996	August–September	11	Davies (1996)
1998	August	14	Mackie (1999)
2001	August	14	Dunham (2002)
2007	September–October	12	Dunham et al. (2007)
2009	September	20	Dunham et al. (2010)

Data analyses

We first analysed the occurrence of unusually wet and drought periods for the five areas, namely Gonarezhou, Buffalo Range Airport, Malilangwe Wildlife Reserve, Save Valley Conservancy and Kruger, over the period 1970 and 2009. Annual rainfall was based on the July–June calendar so as to cover the rainfall which is important ecologically for southern Africa savannas. We calculated the mean annual rainfall, standard deviation (SD) of mean annual rainfall and coefficient of rainfall variation for each of the five areas. Wet or drought

year determination was based on the following formulae: mean annual rainfall ± 1SD, where years with annual rainfall greater than mean annual rainfall +1SD were classified as wet and years with annual rainfall less than mean annual rainfall –1SD were classified as drought (Prins 1996). Second, we determined whether mean annual rainfall for the five areas was significantly different from each other using a one-way analysis of variance with Tukey's Honestly Significant Difference (HSD) *post-hoc* tests using SPSS for Windows version 19 (SPSS Inc., Chicago, IL, USA). Third, we determined whether annual rainfall increased, decreased or remained the same for each of the five areas for the period 1970–2009, using simple linear regression models with year as the independent variable and annual rainfall as the dependent variable.

Fourth, we analysed long-term trends in large herbivore population estimates within Gonarezhou using a flexible nonparametric model in R software for Windows version 2.13.1 (R Development Core Team 2011). For this study, only the large herbivores that are most visible from the air were considered. We focused on nine wild large herbivores which were counted frequently over the study period, and these included one browser, giraffe; three mixed feeders, namely elephant, eland and kudu; and five grazers, namely wildebeest, buffalo, zebra, sable and waterbuck. We used a smoothing model using B-splines (Eilers & Marx 1996) with a break-point (or jump) associated with the 1992 severe drought (identified from preliminary data analysis) to determine the impact of the 1992 severe drought on the selected large herbivore populations. The expected response to the 1992 severe drought would be a decline of the large herbivore population estimates followed by a recovery thereafter. We only used the 1992 severe drought as the break point due to the relatively small data set of aerial surveys conducted between 1984 and 2009. The 1992 drought (annual rainfall = 93 mm) was the driest compared to the 1989 (annual rainfall = 277 mm), 1994 (annual rainfall =

298 mm) and 2005 (annual rainfall = 290 mm) droughts. Moreover, a total of 10 rainy days were recorded at Chipinda Pools rain station in northern Gonarezhou in the 1992 rain season.

The smoothing model produces a smoothed curve of animal numbers over time. A B-spline consists of polynomial pieces, connected in a special way at certain values of x, the knots. B-splines are attractive as base functions for ("nonparametric") univariate regression (Eilers & Marx 1996), and have been successfully applied in analysing long-term animal population estimate data (see Ogutu et al. 2011a). Similar to any nonparametric smoother, B-spline approaches need a smoothing parameter (lambda, λ) to control the smoothness of the fitting curve. A linear combination of third-degree B-splines gives a smooth curve. Too many knots lead to over-fitting of the data; too few knots lead to under-fitting. To prevent over-fitting, a penalty on the second derivative restricts the flexibility of the fitted curve (see Eilers & Marx 1996). In our case, we smoothed the population estimates data of nine wild large herbivore species in Gonarezhou, either side of the period 1984–1991 and 1993–2009, using B-splines of degree 3, a second-order penalty, and 20 intervals. We used a cross-validation method to find the optimal value of λ.

Fifth, we determined the trends of large herbivore populations in Kruger between 1984 and 2006 through graphical analysis in order to establish the influence of wet and drought years on the nine large herbivore population sizes. Sixth, we compared the response to bottom-up processes of the nine large herbivore species yearly survey total population for Gonarezhou and Kruger between 1984 and 1993. We used the total populations of nine large herbivores in 1984 as the reference points, i.e., 100%, in order to establish the similarities in patterns of the total populations of the subsequent years. Seventh, we determined whether rainfall fluctuations recorded in Gonarezhou between 1984 and 2009 had any influence on the selected large herbivore populations by regressing the populations of nine wild large

herbivores against the annual and for lag periods of 1 to 9 years rainfall, using simple linear regression models. To account for multiple testing, we used the Bonferroni correction and considered significant only those relationships for which $P \leq 0.005$ (= 0.05/10). The Bonferroni correction assumes that the tests are independent, and is usually considered a conservative adjustment (Sokal & Rohlf 1995).

Results

Rainfall patterns and trends

Between 1970 and 2009, Gonarezhou recorded three wet years (1977, 1978 and 2000) and six drought years (1973, 1983, 1989, 1992, 1994 and 2005) (Table 2). The recorded number of wet and drought years in Gonarezhou was more or less similar to those recorded in the four adjacent areas. Overall, there was a weak synchrony in the occurrence of wet and drought periods across the five areas, with only the year 2000 being the common wettest period whereas 1973, 1983 and 1992 were the common droughts recorded across the five areas. In particular, the average recurrence of drought in Gonarezhou was ~7 years with drought intervals being random, i.e., 10, 6, 3, 2 and 11 years. Mean annual rainfall for Gonarezhou was 499 mm with a standard deviation (SD) of 195 and a coefficient of variation (CV) of 39%. Mean annual rainfall for the period from 1970 to 2009 did not differ significantly across the five areas (one way ANOVA, $F_{4,195} = 1.02$, $P = 0.398$).

Moreover, there was no indication that annual rainfall declined or increased at all in the five areas: Gonarezhou ($t = –0.28$, $P = 0.780$, slope (beta, β) = –0.003, 95% confidence limits [CL] for β = –0.02 to 0.02), Kruger ($t = –0.27$, $P = 0.689$, β = –0.003, 95% CL for β = –0.02 to 0.02), Malilangwe Wildlife Reserve ($t = 0.45$, $P = 0.652$, β = 0.004, 95% CL for β = –0.02 to 0.02), Save Valley Conservancy ($t = 0.06$, $P = 0.956$, β = 0.001, 95% CL for β = –

0.02 to 0.02) and Buffalo Range Airport (t = –1.02, P = 0.312, β = –0.01, 95% CL for β = –0.03 to 0.01) (Fig. 2). Thus, not a single slope deviated significantly from zero.

Table 2. Annual rainfall for the five study areas and the mean rainfall between 1970 and 2009, with overall year deviations from the annual mean. Unusually wet or drought years are defined as years with more or less than the annual mean plus or minus the standard deviation (SD; see bottom of table) respectively. Common wet and drought years are indicated in bold. *Notes*: AR–annual rainfall (mm), Dev.–deviation, Wt–wet and Dt–drought.

	Zimbabwe												South Africa		
	Buffalo Range Airport			Gonarezhou National Park			Malilangwe Wildlife Reserve			Save Valley Conservancy			Kruger National Park		
Year	AR	Dev.	Wt/Dt	AR	Dev.	Wt/Dt	AR	Dev.	Wt/Dt	AR	Dev.	Wt/Dt	AR	Dev.	Wt/Dt
1970	523	–61		537	38		481	–81		401	–149		412	–118	
1971	355	–229	Dt	381	–118		439	–124		346	–204	Dt	501	–29	
1972	773	189		601	102		627	65		879	329	Wt	849	320	Wt
1973	**302**	**–282**	**Dt**	**177**	**–322**	**Dt**	**213**	**–349**	**Dt**	**281**	**–269**	**Dt**	**316**	**–214**	**Dt**
1974	973	389	Wt	658	159		722	159		512	–38		741	212	Wt
1975	647	63		672	173		789	227	Wt	670	120		667	137	
1976	820	236	Wt	670	171		602	39		749	199	Wt	623	93	
1977	753	169		801	302	Wt	719	157		683	133		687	157	
1978	1120	536	Wt	834	335	Wt	751	189		850	300	Wt	726	196	
1979	734	150		611	112		575	12		552	2		453	–77	
1980	706	122		378	–121		669	107		520	–30		536	7	
1981	762	178		590	91		643	81		681	131		522	–8	
1982	455	–129		387	–112		513	–50		397	–153		354	–176	
1983	**336**	**–248**	**Dt**	**227**	**–272**	**Dt**	**217**	**–346**	**Dt**	**206**	**–344**	**Dt**	**259**	**–271**	**Dt**
1984	424	–160		478	–21		488	–75		492	–58		480	–49	
1985	672	88		566	67		647	85		640	90		761	232	Wt
1986	688	104		567	68		611	48		603	53		424	–105	
1987	287	–297	Dt	318	–181		314	–248	Dt	405	–145		332	–198	Dt

1988	590	6		471	–28		735	173		616	66		585	55	
1989	350	–234	Dt	277	–222	Dt	388	–175		578	28		399	–130	
1990	431	–153		320	–179		424	–139		500	–50		523	–6	
1991	499	–85		467	–32		357	–205	Dt	295	–255	Dt	391	–139	
1992	**127**	**–457**	**Dt**	**93**	**–406**	**Dt**	**72**	**–490**	**Dt**	**157**	**–393**	**Dt**	**238**	**–291**	**Dt**
1993	806	222		511	12		601	38		556	6		520	–10	
1994	556	–28		298	–201	Dt	416	–146		485	–65		339	–191	
1995	479	–105		499	0		607	45		442	–108		511	–19	
1996	609	25		508	9		746	184		584	34		704	174	
1997	576	–8		594	95		573	10		698	148		461	–69	
1998	378	–206		333	–166		415	–148		846	296	Wt	350	–180	
1999	822	238	Wt	575	76		846	284	Wt	843	293	Wt	887	357	Wt
2000	**1177**	**593**	**Wt**	**1118**	**619**	**Wt**	**1213**	**651**	**Wt**	**999**	**449**	**Wt**	**1230**	**700**	**Wt**
2001	543	–41		528	29		624	62		586	36		559	29	
2002	401	–183		330	–169		357	–205	Dt	419	–131		451	–78	
2003	715	131		675	176		737	175		726	176		333	–197	Dt
2004	643	59		647	148		756	193		491	–59		694	164	
2005	289	–295	Dt	290	–209	Dt	374	–188		342	–208	Dt	384	–146	
2006	384	–200		323	–176		568	6		544	–6		665	136	
2007	615	31		655	156		547	–16		473	–77		357	–173	
2008	553	–31		539	40		641	79		613	63		495	–35	
2009	480	–104		461	–38		475	–88		343	–207	Dt	469	–61	
Annual mean	584			499			562			550			530		
SD of mean	225			195			203			189			197		
Variability (%)	39			39			36			34			37		

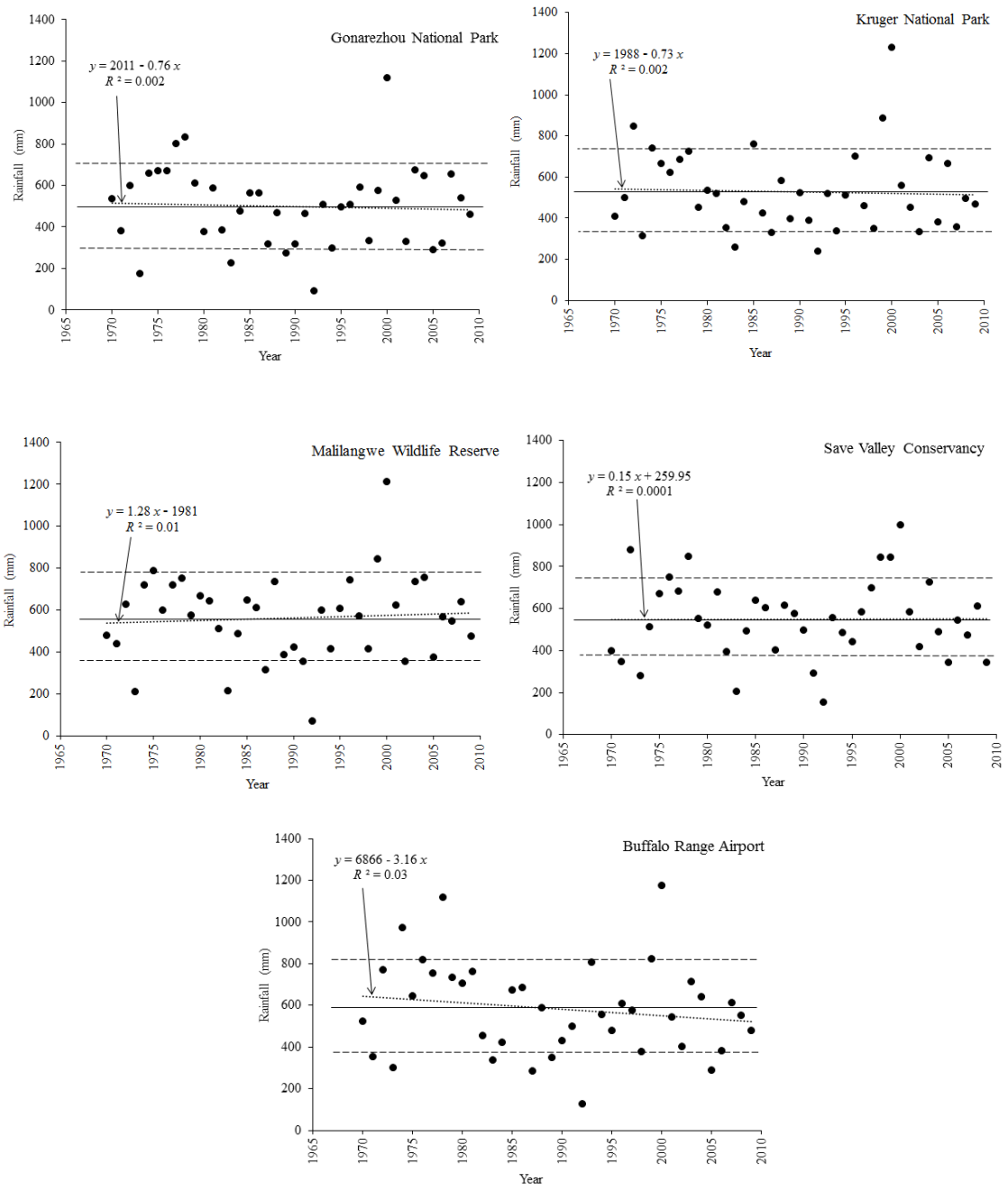
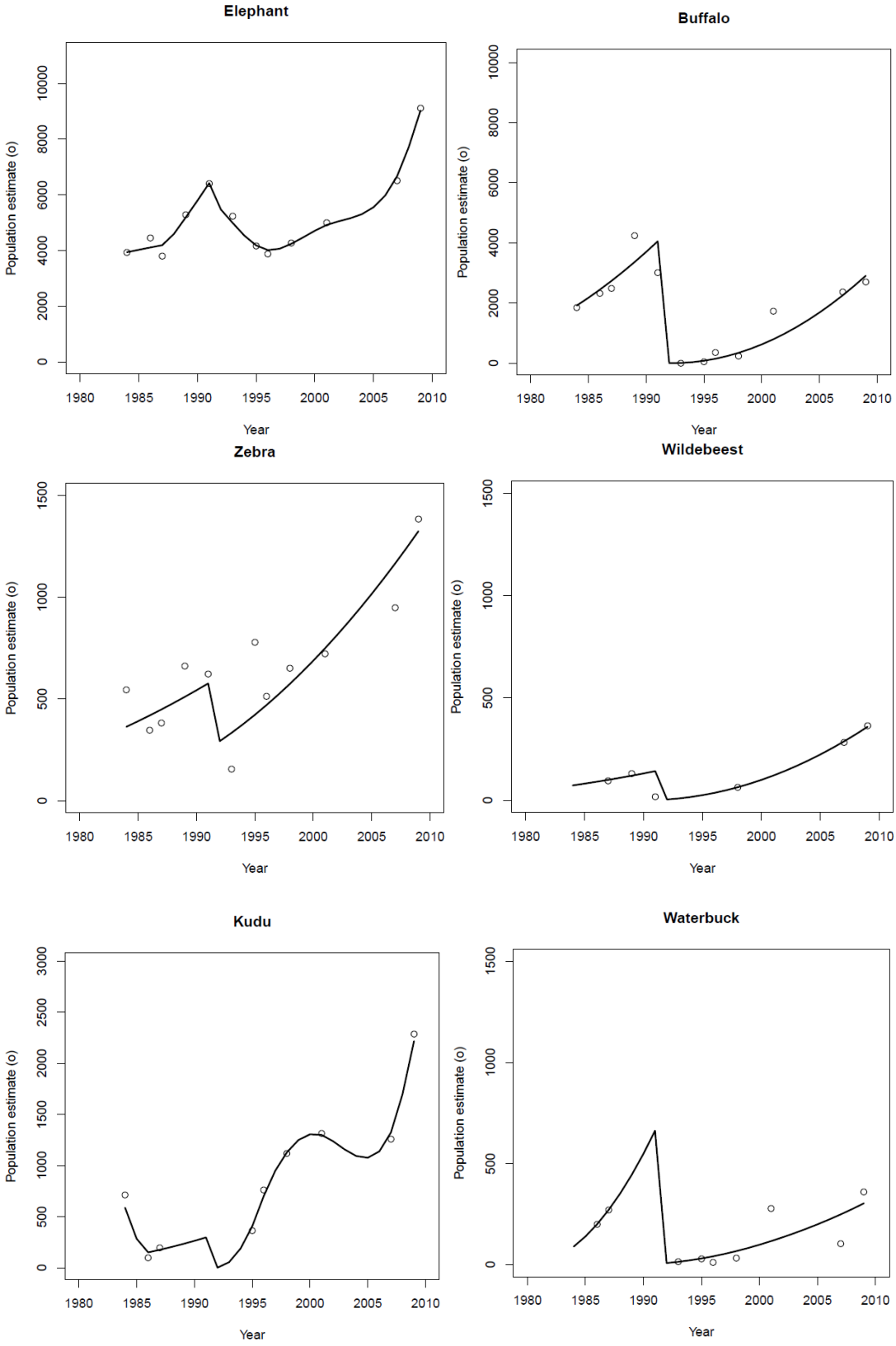


Fig. 2. Patterns and trends of rainfall for Gonarezhou National Park, Malilangwe Wildlife Reserve, Save Valley Conservancy and Buffalo Range Airport in Zimbabwe and Kruger National Park, South Africa, between 1970 and 2009. *Notes*: The solid lines represent the mean rainfall and the two broken lines represents ±1SD (standard deviation) of the mean. Dotted lines represent the long-term trends of annual rainfall.

Animal population trends

The population trends for nine wild large herbivore species in Gonarezhou between 1984 and 2009 are shown in Fig. 3. Populations for six species (elephant, buffalo, giraffe, zebra, waterbuck and wildebeest) increased between 1984 and 1991 whereas populations of three other species (eland, kudu and sable) declined during the same period. With the exception of the small ($N < 300$) giraffe populations and small ($N < 300$) sable populations, populations for seven species (elephant, buffalo, eland, zebra, kudu, wildebeest and waterbuck) show a dip associated with the 1992 drought. Thereafter, populations for these seven species increased in Gonarezhou. However, based on the modeled trend, only populations of five species (elephant, giraffe, zebra, wildebeest and kudu) increased to above the abundance levels recorded prior to 1992 whereas the populations for two species (buffalo and sable) were slightly lower than those recorded before 1992. Only kudu and waterbuck show a slight dip around 2005 possibly associated with the 2005 drought recorded in Gonarezhou and the species' population increased thereafter.

In the adjacent Kruger, populations for seven species (buffalo, eland, kudu, sable, waterbuck, wildebeest and zebra) declined following the 1992 drought (Fig. 4a, b). Only elephant population increased whereas giraffe population was slightly negatively affected by the 1992 drought. Increases in animal abundances after the 1992 drought were recorded for buffalo, waterbuck and zebra. In contrast, eland and sable populations continued to decline after the 1992 drought. Overall, an almost similar response to bottom-up processes in the nine large herbivore species' total population sizes between 1984 and 1993 was evident between Gonarezhou and Kruger (Fig. 5).


Elephant
Buffalo
Zebra
Wildebeest
Kudu
Waterbuck
Population estimate (o)
Year
0
500
1000
1500
2000
2500
3000
4000
6000
8000
10000
1980
1985
1990
1995
2000
2005
2010

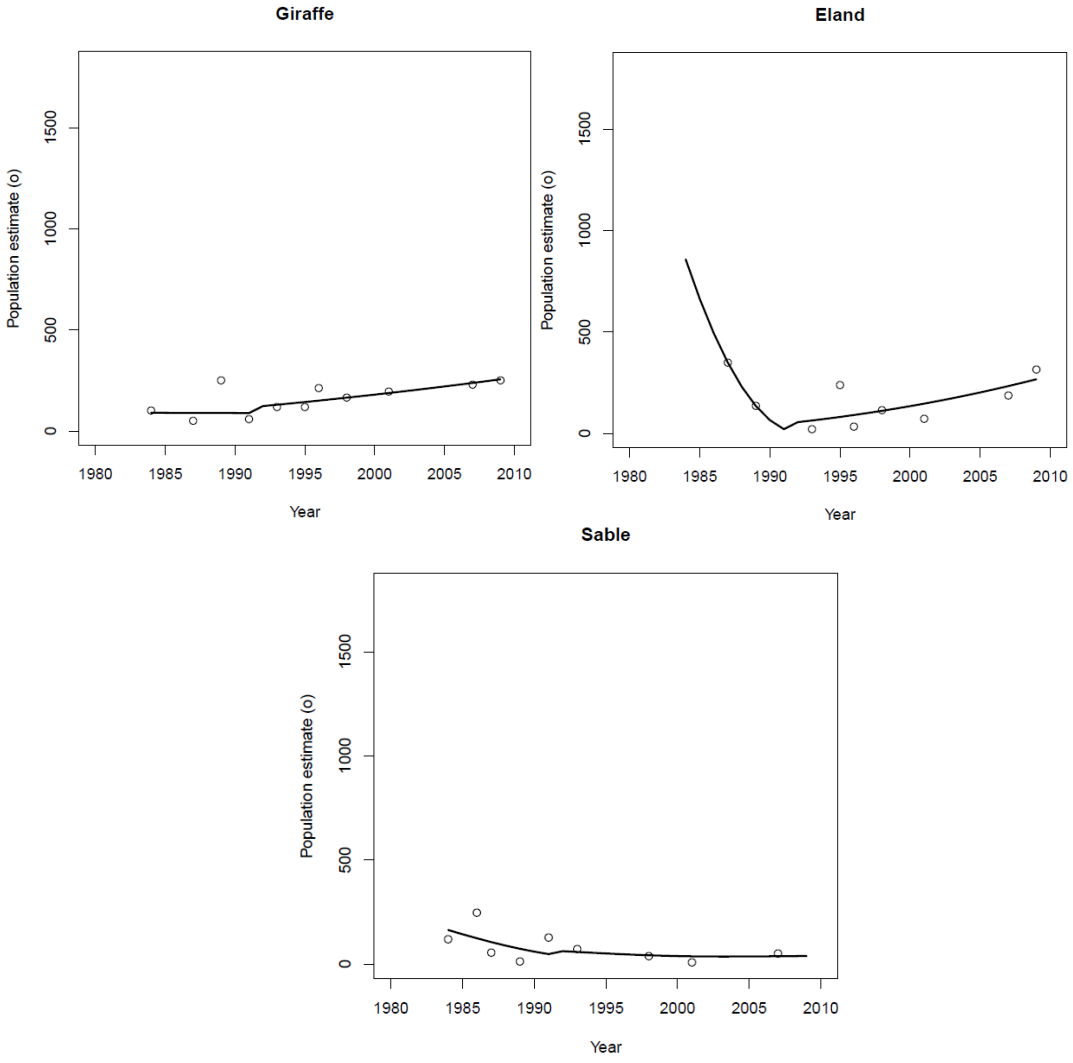


Fig. 3. Temporal trends in nine wild large herbivores in Gonarezhou National Park, Zimbabwe during 1984–2009. The lines represent the fitted trends according to a smoothing model using B-splines (Eilers & Marx 1996; see Methods).

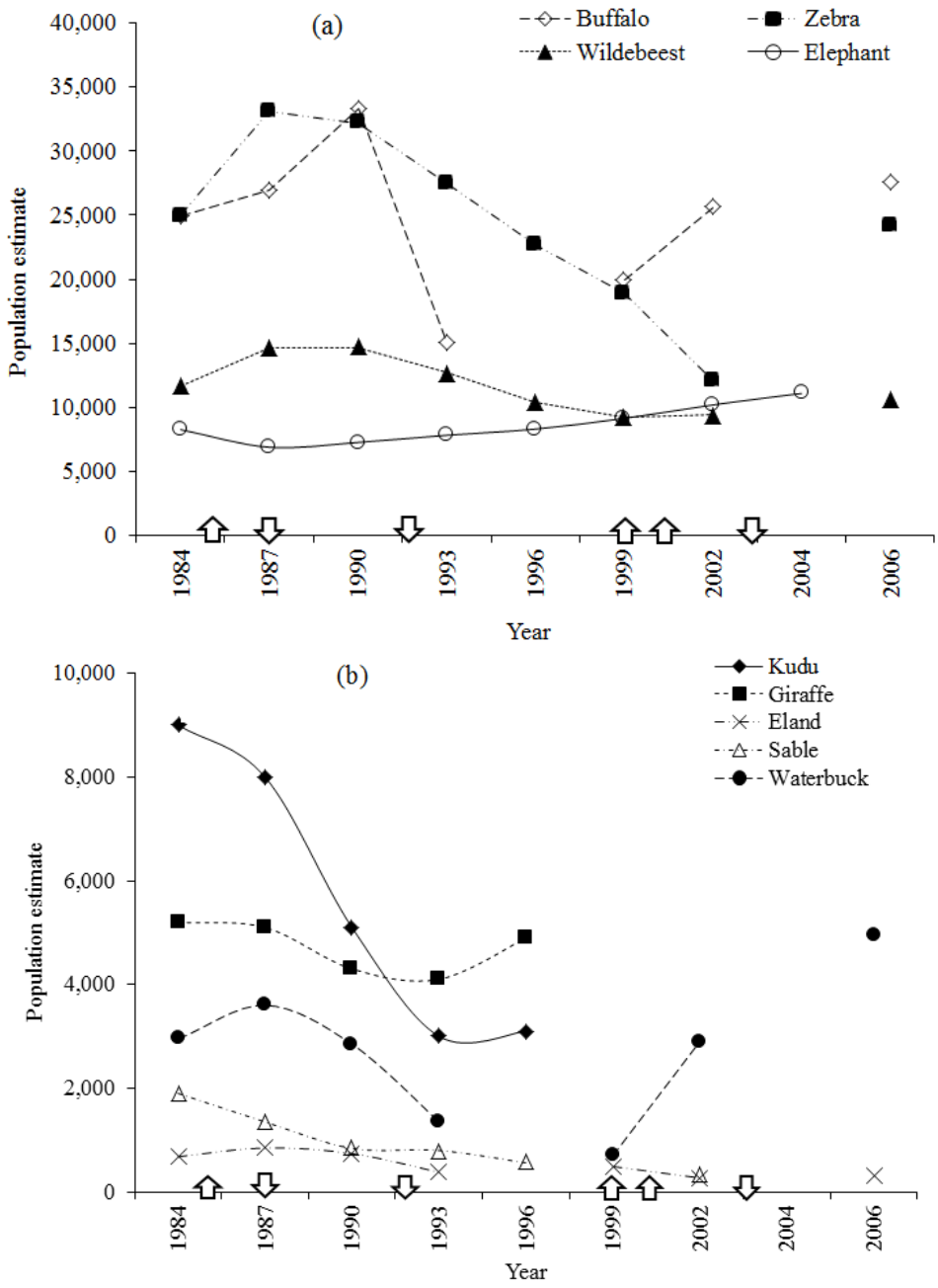


Fig. 4(a, b). Large herbivore population estimates in Kruger National Park, South Africa between 1984 and 2006. *Notes*: Up arrow represents wet year and down arrow represents drought year. Population estimate data for kudu and giraffe were unavailable after 1996. *Source*: Ogutu and Owen-Smith (2003), Van Aarde et al. (1999), Young et al. (2009) and Seydack et al. (2012).

Fig. 5. Population size development for nine large herbivores in Gonarezhou and Kruger National Parks between 1984 and 1993 with reference to the 1984 total populations. *Note*: Down-arrow represents the 1992 severe drought which was common in both protected areas.

Influence of rainfall on large herbivore populations

There were no significant linear relationships between rainfall (annual and for lag periods of 1 to 9 years) and the nine large herbivore species populations (elephant, giraffe, buffalo, eland, kudu, wildebeest, zebra, sable and waterbuck) in the years of census (after Bonferroni corrections, all $P > 0.005$). Furthermore, abundances for six species (elephant, buffalo, giraffe, kudu, zebra and waterbuck) slightly increased following the wet year, i.e., 2000, whereas populations of eland and sable slightly declined after 2000. Overall, abundances for

five species (elephant, buffalo, giraffe, wildebeest and zebra) slightly increased following average and above average annual rainfall years, i.e., 1985, 1986, 1996 and 2007, whereas kudu and waterbuck abundances were almost similar whilst eland and sable abundances slightly declined during the same years.

Discussion

Our study showed that mean annual rainfall for Gonarezhou and the four adjacent areas (Buffalo Range Airport, Malilangwe Wildlife Reserve, Save Valley Conservancy and Kruger) between 1970 and 2009 was similar with the peak wet and drought periods overlapping to a large extent despite the 700 km length of the entire study region. The weak synchrony, particularly, of droughts have been reported to occur in some ecosystems with geographic diversity and different atmospheric patterns that control precipitation across landscapes being attributed as causes of the weak synchronicity (Prins & Loth 1988; Vicente-Serrano & Cuadrat-Prats 2007). Because of the temporal heterogeneity that may be caused by large variations in rainstorm effects across wildlife areas during drought periods in semi-arid areas, the spatial heterogeneity can be crucial for the survival of local herbivores through influencing the animal feeding patterns and their distribution (Drent & Prins 1987). Therefore, this suggests that animals can move to areas which are slightly less bad containing key forage and surface water resources and hence, soften the fall in food production during drought periods.

Gonarezhou is largely an open system, with no fences, unlike the Kruger. The large fluctuations and variability of population estimates particularly between 1991 and 1993, suggests that some animals could have moved in and out of Gonarezhou, particularly to the adjacent communal areas, game farms in Mozambique or even to South Africa, in a search for suitable forage resources. Recent evidence suggests that elephants move between Gonarezhou

and Kruger (Save the Elephants, South Africa, unpublished data), and between Gonarezhou and Mozambique (Gonarezhou Conservation Project, unpublished data). In Kenya, elephants migrated out of the Mpala Ranch to adjacent ranches within the Laikipia-Samburu ecosystem following the 2000 drought and only returned during the wet seasons (Augustine 2010). Furthermore, movement of large herbivores across ecosystems following droughts in the 1980s have been documented in southern Africa (Walker et al. 1987). This, therefore, suggests the need to manage large herbivore populations at scales larger than individual protected areas (Augustine 2010), and in our case focus should be on managing wild large herbivores at the Great Limpopo Transfrontier Conservation Area level (Van Aarde & Jackson 2007). Accordingly, it has been suggested that the removal of fences whenever practical should be encouraged to allow for animal movements, particularly, during the drought periods (Shrader et al. 2010).

Our results show that large herbivore species' response to the 1992 severe drought in Gonarezhou was not identical. A short-term decline in seven large herbivore species, namely elephant, buffalo, eland, zebra, kudu, wildebeest and waterbuck, associated with the 1992 severe drought and their subsequent recovery between 1984 and 2009 was recorded in Gonarezhou. A more or less similar trend in large herbivore species' population response to bottom-up processes was recorded in the Kruger, suggesting a synchrony in large herbivore population response to bottom-up processes between Gonarezhou and Kruger. Environmental variation can explain the spatial population synchrony (Moran 1953; Hegel et al. 2012), in our case rainfall variation. In addition, only kudu and waterbuck appeared to be slightly negatively affected by the less severe drought of 2005 in Gonarezhou. It has been reported that a total of 592 elephant carcasses were counted in 1993 and 2700 buffaloes died in the period 1992–93 in Gonarezhou whereas about 750 elephants, 400 buffaloes, 60 zebra, 50 elands and 64 waterbuck were translocated outside of Gonarezhou between 1984 and 1993 to

rescue them from dying due to droughts (Sharp 1986; Bowler 1993; Leggett 1994). Thus, the recorded population trend for elephant and buffalo in the 1980s and early 1990s could also have been influenced by the animal culling that took place during this time. Approximately, 3800 elephants and 380 buffaloes were culled in Gonarezhou between 1984 and 1993 (Sharp 1986; Bowler 1993). Culling in Gonarezhou was stopped in 1993. In southern Africa, culling was practiced in order to avoid progressive deterioration of habitat (Walker et al. 1987), a practice commonly associated with rangeland management using the equilibrium concept. However, the non-equilibrium concept suggests that rangeland degradation is unlikely to occur where rainfall variability is high, because herbivore populations collapse in periods of drought, enabling vegetation to recover (Von Wehrden et al. 2012).

Only giraffe appeared to be least affected by the four droughts (1989, 1992, 1994 and 2005) recorded in Gonarezhou between 1984 and 2009 possibly due to availability of browsing resources, at least for some time, during the drought periods. Similarly, in Kruger, giraffe was slightly negatively affected by the 1992 severe drought (Fig. 4) as has also been previously reported (Owen-Smith & Ogutu 2003). In contrast, sable populations in Gonarezhou and Kruger showed little recovery after the 1992 drought and even in years with average to above average rainfall. This trend of declining sable population could be a result of the high variation in annual rainfall (Georgiadis et al. 2003; Owen-Smith et al. 2012) influencing the key forage resources and/or other top-down forces which still need to be further investigated. Surprisingly elephant populations in Kruger were less affected by the 1992 drought than elephants in Gonarezhou. Gonarezhou had a density of 1.2 elephants/km^2 in 1991 whereas Kruger had a density of 0.3 elephants/km^2 in 1990. Elephants in Kruger were maintained at low densities through culling between 1967 and 1994 (Van Aarde et al. 1999). Hence, it's likely that due to the higher elephant densities in Gonarezhou, massive die-offs occurred following the 1992 drought due to reduced forage resources availability than in

Kruger. But there was culling (too). Moreover, it is not easy to understand from Fig. 3 why elephant decline continues till 1996 in Gonarezhou.

Declines in large herbivores associated with severe droughts negatively affecting forage availability have been documented in savanna ecosystems in the past. For example, the 1983 and 1992 droughts were reported to have led to declines in large herbivore populations in Botswana (Williamson & Mbano 1988) and in Kruger (this study; Harrington et al. 1999; Marshal et al. 2011; Seydack et al. 2012). Foley et al. (2008) documented the decline of elephant populations during a severe drought in Tanzania in 1993 which coincided with an upsurge in elephant poaching (Prins & Van Der Jeugd 1993; Prins et al. 1994). Similarly, Dunham (1994) reported a high mortality of large grazers in the Mana Pools National Park, northern Zimbabwe, following the 1992 drought. Droughts have been reported to have devastating impacts on large herbivore populations directly through starvation, and indirectly by weakening animals and hence, amplifying their vulnerability to predation, diseases and parasites (Ogutu et al. 2008). Quantity and quality of forage in semi-arid areas is largely influenced by rainfall which is a proxy for primary productivity (Deshmukh 1984; Mduma et al. 2001). The occurrence of a drought in an ecosystem negatively influences wildlife populations through reduced food availability (Ogutu et al. 2011b; Grange et al. 2012), negatively affecting the nutritional status of herbivores (Owen-Smith 1990; Prins & Olff 1998). Moreover, it has been suggested that rates of decline in drought years are typically higher than rates of increase in wet years for large-bodied herbivore populations which are limited by rainfall (Illius & O'Connor 2000). Similarly, our study also provides evidence to suggest that most of the herbivore species' populations slightly increased after average and above average rainfall (1985, 1986, 1996 and 2007) and wet year (2000), with only a few species' abundances slightly declining and/or remaining the same following average, above average rainfall and wet year. It is, therefore, likely that animal population growth in most

large herbivore species is best promoted when annual rainfall is close to the long-term average for a few years which enhances primary production of key forage resources.

Overall, we did not detect any significant relationship between rainfall and large herbivore populations in Gonarezhou for the period 1984 and 2009. Similar results of no significant influence of annual rainfall on large herbivore populations were also reported for the Katavi-Rukwa ecosystem of western Tanzania (Caro 2008). However, in Kruger, the buffalo population was found to be strongly related to rainfall which was lagged for 3–5 years whilst wildebeest and zebra were reported as not sensitive to lagged rainfall (Mills et al. 1995). This difference in the relationship between buffalo population and lagged rainfall in Kruger could be attributed to the fact that Mills et al. (1995) did not use a Bonferroni correction in their analysis which may have affected the multiple regression results. Thus, general rules cannot be easily deduced from these findings. Variations in large herbivore species responses to rainfall across ecosystems could possibly be related to landscape heterogeneity in grass production which is influenced by soil fertility and rainfall (Augustine et al. 2003). Furthermore, it has been suggested that a CV of 33% or greater is a threshold for which non-equilibrium dynamics become relevant in an area (Ellis & Swift 1988; Boone & Wang 2007). Therefore, for some species non-equilibrium dynamics may be very important (e.g., buffalo) and others not (e.g., giraffe).

Our findings on the basis of long-term aerial survey data are consistent with earlier studies which have documented that protected areas in southern Africa have largely maintained their animal populations (Blanc et al. 2005; Junker et al. 2008; Valeix et al. 2008; Craigie et al. 2010; Dunham 2012). The recorded increases in some wild large herbivore populations in Gonarezhou could partly be attributed to the consistent and recent increases in law enforcement which helped reduce illegal hunting, particularly, during Zimbabwe's economic decline associated with the political crisis and land reforms (Gandiwa et al. 2013b)

that were widely publicized in the international media (Chapter 5). Moreover, the linkages (collaborative management of wildlife) between Gonarezhou and adjacent wildlife areas, for instance, under the Communal Areas Management Programme for Indigenous Resources, within the southeast lowveld of Zimbabwe, and the Great Limpopo Transfrontier Conservation Area could also have helped in the protection of large herbivore species. Elsewhere, several authors have reported steady reductions in wild herbivore abundances across the African continent in the recent past (Fischer & Linsenmair 2001; Ottichilo et al. 2001; Estes et al. 2006; Caro 2008; Craigie et al. 2010; Ogutu et al. 2011a; Bouché et al. 2012). These declines in large herbivore populations have been attributed to recurrent droughts, human encroachment into wildlife areas, land-use changes, poaching, diseases, counting errors and biases, and competition with domestic stock (Du Toit & Cumming 1999; Ottichilo et al. 2000; Ogutu & Owen-Smith 2003; Ogutu et al. 2011a; Scholte 2011).

Although the statistical model used in this study produced relatively satisfactory results in terms of understanding the role of the 1992 severe drought and the general trends of large herbivores in Gonarezhou between 1984 and 2009, it must be pointed out that the relative confidence limits of some species population estimates are broad, e.g., waterbuck and eland, and hence the modeled trend appeared not to fit very well at some period for these species. Sample aerial surveys of large herbivores in savanna ecosystems are generally associated with wide confidence limits of population estimates, especially of low abundant species due to observer bias, sampling intensity and clustering patterns of some species (Caughley 1974; Khaemba & Stein 2002; Ferreira & Van Aarde 2009). Overall, the statistical model provides a useful approach to evaluate the long-term trends of large herbivores and the bottom-up effects of severe droughts in savanna ecosystems. For instance, the statistical model was instrumental in showing the species that were most negatively affected, e.g., buffalo, elephant and zebra, by the 1992 drought and those that were not affected, e.g., giraffe

in Gonarezhou. Our study therefore, suggests that it is also important to really understand fecundity, calf survival, and age- and condition-related mortality (e.g., Owen-Smith et al. 2005; Trimble et al. 2009; Ogutu et al. 2010), particularly following wet and drought periods, thus, emphasizing that aerial census data are no substitute for large herbivore population studies when it comes to understanding animal population fluctuations in these communities. Hence, this calls for ground surveys, e.g., road counts, to complement aerial survey data on large herbivore population composition.

Conclusion

Our results partly support the first prediction that there is a synchrony in rainfall and drought occurrence within the same region, i.e., areas lying close to each other, since we found some variations in drought occurrences across the study area. Furthermore, our results showed that there were some dips, some upswings associated with only one drought (i.e., 1992) in seven large herbivore species in Gonarezhou. Similarly, declines in some large herbivore species were also recorded in Kruger following the 1992 drought, suggesting a synchrony in large herbivore population response to bottom-up processes between Gonarezhou and Kruger. Moreover, annual rainfall appeared not to significantly influence large herbivore abundances in Gonarezhou. Our results partly support the second prediction that large herbivore populations would decline following droughts. Variations in rainfall (bottom-up processes), especially severe drought occurrences, influence large herbivore populations in African savannas but our data show a very variable response between different herbivore species, thus precluding easy general conclusions.

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CHAPTER 3: Illegal hunting and law enforcement during a period of economic decline in Zimbabwe: A case study of northern Gonarezhou National Park and adjacent areas*

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Abstract

Illegal hunting of wildlife, or top-down harvesting, is a major issue in today's society, particularly in tropical ecosystems. There has been widespread concern about increasing illegal hunting of wildlife in most conservation areas in Zimbabwe following the political instability and economic decline the country faced since 2000. In this study, we focused on the northern Gonarezhou National Park, a large and unfenced protected area, and adjacent communal areas in southern Zimbabwe. We hypothesised that illegal hunting activities would (1) be perceived to have increased due to economic collapse, and (2) vary with law enforcement efforts. A total of 236 local residents from eight villages adjacent to the northern Gonarezhou were interviewed using semi-structured questionnaires from December 2010 to May 2011, and law enforcement data for northern Gonarezhou between 2000 and 2010 were retrieved from the park law enforcement database. A total of 26 animal species were reportedly hunted. Bushmeat consumption and the need for local trade to raise income were reported as the main reasons behind illegal hunting. Contrary to the first hypothesis, the majority of respondents (n = 156, 66%) reported that illegal hunting activities had declined between 2000 and 2010 largely due to increased park protection as also supported by law enforcement data. A total of 22 animal species were recorded as having been illegally hunted in northern Gonarezhou. The number of illegal hunters arrested declined with increased law enforcement efforts although the number of wire snares recovered and hunting dogs shot appeared to increase following increased law enforcement efforts. These results partly support the second hypothesis that illegal hunting activities would vary with law enforcement efforts.

Keywords: Bushmeat; conservation; economic collapse; poaching; protected area; snaring

Introduction

In tropical areas, humans are commonly physically inseparable from natural systems due to the heavy dependence of local people on natural resources for their subsistence living (Robinson & Bennett 2004; Singh & Sharma 2009). However, this can lead to unsustainable forms of hunting. Illegal hunting, also known as poaching, is the taking of any kind of wildlife, including fish, in such a way that it violates local, national and international wildlife laws (e.g., Duffy 1999). Illegal hunting is often unsustainable and has led to reductions and/or local extinctions of many wildlife populations across the tropical ecosystems (Peres 2000; Bennett et al. 2002; Ceballos & Ehrlich 2002; Milner-Gulland et al. 2003; Corlett 2007; Emery 2007; Bennett 2011; Wilkie et al. 2011; Paudel & Kindlmann 2012).

Illegal hunting involves the use of traditional hunting methods such as bow and arrows, snares, pitfalls (Noss 1998; Kümpel et al. 2008; Tumusiime et al. 2010), but also the illegal use of fire-arms, explosives, poisons and more recently small aircraft aided techniques and immobilisation drugs. Illegal hunting is particularly severe where rural people hunt within poorly managed protected areas (Fusari & Carpaneto 2006). Although law enforcement patrols attempt to control illegal hunting activities for bushmeat (meat derived from wild animals), and/or commercial sale within conservation areas (Jachmann 2008a, b; Kaltenborn et al. 2008), the expected financial benefits from such activities are far greater than the costs associated with a low probability of arrest and punitive fines (Campbell & Hofer 1995; Loibooki et al. 2002; Moyle 2009; Bennett 2011). Illegal hunting is also influenced by a poor definition of property rights to wildlife species such as no owner (*res nullius*) status (Child & Chitsike 2000; Bulte & Horan 2002). When property rights are poorly defined, humans can be expected to expand their hunting effort as long as hunting is more beneficial (profitable) than alternative activities, or until there are zero profits in hunting for bushmeat (Bulte & Horan 2002). Enforcement efforts against wildlife trade in developing countries have generally been

unstructured, unstrategic and underfunded; hence allowing the proliferation of illegal wildlife trade (Parr 2011).

Illegal hunting is a major problem throughout Africa (Barnes 2002; De Boer et al. 2007; Fa & Brown 2009; Brashares et al. 2011; MacKenzie 2012a). Most illegal hunting studies in Africa have concentrated on central and western tropical forests on the mainland (Wilkie & Carpenter 1999; Barnes 2002; Brashares et al. 2004; Fa et al. 2006; Bennett et al. 2007; Laurance et al. 2008; Kümpel et al. 2010). Illegal hunting issues are increasingly receiving attention in the wildlife rich savanna and miombo woodlands of east and southern Africa as growing evidence suggests that illegal hunting represents high conservation threats in some parts of these regions (Barnett 2000; Fusari & Carpaneto 2006; Golden 2009; Hayward 2009; Nyahongo et al. 2009; Jenkins et al. 2011; Lindsey et al. 2011b).

Publicly or state owned protected areas are common property regimes which are set aside for the benefit of society, with the main purpose being the conservation of biodiversity (Naughton-Treves et al. 2005; Clerici et al. 2007; Gaston et al. 2008; Holland 2012). However, disturbances associated with political unrests and economic collapse may result in increased illegal hunting (Kanyamibwa 1998; Yamagiwa 2003; Rowcliffe et al. 2004; De Merode et al. 2007) due to weak policy instruments associated with poor management of natural resources (Bunnefeld et al. 2011). Policy instruments are important in the management of common pool resources, such as wildlife resources, and addressing social dilemmas (Leeuwis & van den Ban 2004). Social dilemmas are situations in which autonomous individuals act in their own rational self-interest, yet the collective outcomes of these independent actions threaten misfortune to all (Karp & Gaulding 1995; Ostrom 2010). Collapse in law enforcement can result in a protected area becoming more characteristic of an open access resource, therefore, leading to a situation reminiscent of what has been classically called “tragedy of the commons” (Hardin 1968; Berkes et al. 1989) where individuals from

local communities maximise gain from wildlife resources through increased illegal hunting (Sibanda 1995). Such increased illegal hunting activities, a form of wildlife crime, often leads to species becoming overexploited to increase short-term profits while endangering and eliminating a natural resource for future users (Pires & Moreto 2011). Past studies suggest that illegal hunting activities seem to vary with law enforcement efforts. For instance, poor law enforcement efforts have been linked to declines in wildlife populations as a result of increased illegal hunting (Bassett 2005; Ogutu et al. 2011a). In contrast, improved law enforcement efforts have been associated with a reduction in illegal hunting activities (Leader-Williams et al. 1990; Jachmann 2008b, a; Martin 2010). Furthermore, illegal hunting activities have been reported to decrease with an increase in: (i) distance from a protected area boundary (Wilfred & MacColl 2010), and (ii) benefits accrued by local communities from wildlife conservation (Johannesen 2006). In contrast, illegal hunting activities have been reported to increase with an increase in human population density inside and/or adjacent to a protected area (Newmark 2008; Metzger et al. 2010).

Previous studies provide evidence which suggests that illegal hunting has emerged as a serious conservation threat in Zimbabwe (Duffy 1999; Wolmer 2005; Mapedza & Bond 2006), particularly in fenced privately owned conservation areas that were negatively affected by the land reform process which began in 2000 (Chaumba et al. 2003a; Wels 2003; Degeorges & Reilly 2007; Lindsey et al. 2011b; Williams 2011). However, there is a gap in literature concerning the extent of illegal hunting and law enforcement efforts in state protected areas in Zimbabwe. These areas are largely unfenced and were less affected by the land reform process since they were not targeted for resettlement under the fast track land reforms. In the present study, we attempt to contribute to the understanding of illegal hunting in a state owned protected area bordering communal areas implementing community based natural resources management programs, namely Communal Areas Management Programme

for Indigenous Resources (CAMPFIRE), using a case study from southern Zimbabwe. Wildlife in Zimbabwe is *res nullius* (Cumming 1999). State protected areas in Zimbabwe, particularly national parks, differ from private protected areas in that they have lower manpower levels, fewer financial resources for conservation and are bordered by communal areas which mostly have CAMPFIRE programs that help local communities and natural resources conservation.

This study focusses on the period covering the political instability and economic decline in Zimbabwe. Between 2000 and 2008, Zimbabwe faced a severe economic crisis (Coltart 2008). The national currency was drastically devalued and the cost of living rose continually (Hanke & Kwok 2009). Many communities especially those in remote areas and around protected areas were left suffering high unemployment and shortages of food and other basic supplies (Coltart 2008). Although sport-hunting in CAMPFIRE areas continued, the cash dividends to local people had little impact on relief of hardships (e.g., Balint & Mashinya 2006). This study, therefore, concentrates on the largest national park in southern Zimbabwe, namely the northern Gonarezhou National Park (hereafter, Gonarezhou) and adjacent local communities. Specifically, we hypothesised that illegal hunting activities would (1) be perceived to have increased due to economic collapse, and (2) vary with law enforcement efforts.

Materials and Methods

Study area

Criteria used to select the study area were (i) a large and unfenced protected area (national park) in southern Zimbabwe, and (ii) existence of local communities with community based natural resources management programs adjacent to the protected area. The northern Gonarezhou, namely Chipinda Pools and four wards namely, Chibwedziva and Chizvirizvi

falling under the Chiredzi district, and Mahenye and Mtandahwe falling under the Chipinge district, adjacent to the northern Gonarezhou, southeastern Zimbabwe were selected (Fig. 1). Established in the early 1930s as a Game Reserve, Gonarezhou was upgraded to a national park under the *Parks and Wildlife Act* of 1975. Gonarezhou was initially fenced during the early 1970s but by the 1990s, most of the fence was lost to vandalism and theft. The study area forms part of the Great Limpopo Transfrontier Conservation Area. Gonarezhou is the second largest national park in Zimbabwe after Hwange National Park and covers an area of approximately 5050 km^2 and is located between 21° 00′–22° 15′ S and 30° 15′–32° 30′ E.

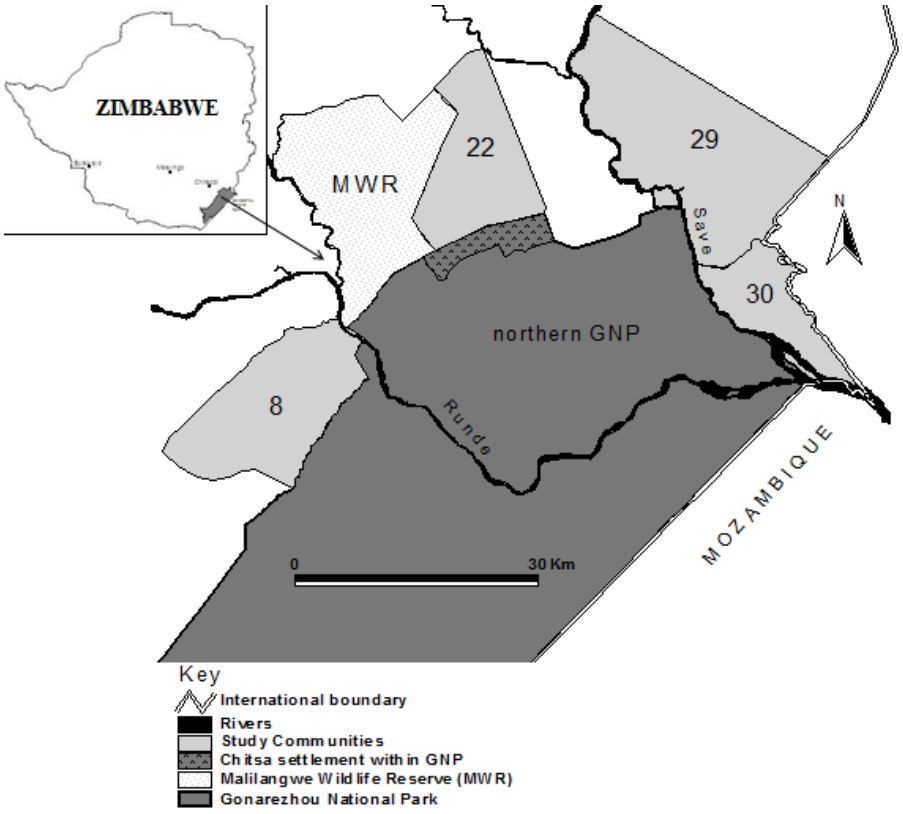

Fig. 1. Location of the four study wards adjacent to the northern Gonarezhou National Park, south-eastern Zimbabwe. *Notes*: 8 – Chibwedziva ward, 22 – Chizvirizvi ward, 29 – Mtandahwe ward and 30 – Mahenye ward.

There is a wide variety of large herbivore species in Gonarezhou and these include the African elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), African buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), plains zebra (*Equus quagga*), waterbuck (*Kobus ellipsiprymnus*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger*), blue wildebeest (*Connochaetes taurinus*), eland (*Taurotragus oryx*), kudu (*Tragelaphus strepsiceros*), nyala (*Tragelaphus angasii*) and impala (*Aepyceros melampus*). The park is also endowed with a variety of large carnivores including the African lion (*Panthera leo*), leopard (*Panthera pardus*) and spotted hyena (*Crocuta crocuta*) (Gandiwa 2012).

The dominant ethnic group in the study area is Shangaan. Local residents in communities adjacent to the northern Gonarezhou practice a combination of subsistence, cash crop farming and livestock production (Gandiwa 2011). These communities manage their natural resources under CAMPFIRE programs implemented since 1982 in an effort to generate benefits for local communities that otherwise had been deprived by protection policies (Martin 1986; Murphree 1988; Child 1993).

Data collection

Perceptions of illegal hunting and protected area law enforcement

Data on local people's perceptions of illegal hunting were collected from eight villages occurring in the four study wards, i.e., two villages per ward, using semi-structured questionnaires administered through face-to-face interviews from December 2010 to May 2011. Perceptions are important because they reflect local people's habitual way of life, as well as their shared expectations or experiences with an activity (Uddin & Foisal 2007). Current village registers of the selected eight study villages formed the sampling pool and

households were randomly selected through picking of numbers from a hat that corresponded to the households from each study village register. The household heads were targeted as the respondents. In case of their absence, another permanently resident adult (≥ 18 years) in the households took part in the interview in his/her residence. Interviews were conducted conditionally upon the individual's willingness to fully participate. Respondents were local villagers and no distinction was made between hunters and non-hunters. This was done to encourage local residents to openly provide illegal hunting information which can be regarded as sensitive.

The date for interview was communicated to each selected household one or two days in advance. Our questionnaire development was informed by a previous survey of perceptions of illegal hunting in southeastern Zimbabwe (Gandiwa 2011). Questions were constructed to seek information on the general perceptions of illegal hunting practices inside Gonarezhou and adjacent areas between 2000 and 2010. Data collected included information on frequency of sighting bushmeat and/or wild animal products being traded, perceptions of illegal hunting trends, hunted animal species, reasons for hunting, and perceptions of protection status in the protected area (Table 1). With the help of one field assistant conversant in local language acting as a translator, we interviewed a total of 236 local residents, who consisted of 146 (62%) men and 90 (38%) women. Interviews took on average approximately 54 minutes (range: 38–76 min) to complete.

Table 1. Outline of the semi-structured questionnaire used in the household survey in the four study wards adjacent to northern Gonarezhou National Park, Zimbabwe.

Questions	Options provided
Between 2000 and 2010, how often did you see bushmeat or wild animal products being traded in your village or ward?	Once in 30 days/ once between 31 and 180 days/ once in >6 months/year
In your opinion, what is the trend of illegal hunting of wild animals your ward and adjacent Gonarezhou National Park in last eleven years, i.e., between 2000 and 2010?	Increased/ decreased/ remained the same
What are the reasons for the given trend in illegal hunting?	Open
May you list the wild animal species that were commonly hunted illegally in your ward and nearby Gonarezhou National Park between 2000 and 2010?	Open
In your opinion what are the main reasons why people engage in illegal hunting activities in the area?	Open
What do you think is the trend of protection given to wildlife conservation by the government between 2000 and 2010?	Increased/ decreased/ remained the same

Protected area law enforcement and illegal activities

We extracted law enforcement data on patrol intensity and evidence of illegal activities in northern Gonarezhou for the period 2000 to 2010 from the law enforcement database kept at

Chipinda Pools in Gonarezhou. Gonarezhou uses the conventional law enforcement in the form of foot patrols that start from each of the ranger camps as well as from the stations' main and sub-offices. Almost all local (day) and long (over several days) patrols are done during the day in Gonarezhou. Only strategic or ambush patrols may extend to the night with patrol rangers remaining in one particular location, often near a frequently used poaching trail, but sometimes in response to intelligence information. Standardised patrol forms were used to keep records of the number of staff on patrol, the exact duration, the area travelled, types, quantities and locations of illegal activity encountered including number of hunters and dogs, number caught, or shot in the case of dogs, number of snares recovered, number and species of animals killed in each incident. The method of conventional law enforcement has been discussed fully elsewhere (Jachmann 2008a, b; Jachmann et al. 2011).

A patrol team in Chipinda Pools normally has four or five patrol rangers. This patrol team size is considered appropriate in savanna ecosystems (Jachmann 2008a, b). In northern Gonarezhou, patrol data were checked at debriefing by the Senior Rangers, then by the Senior Wildlife Officer in charge of law-enforcement operations before being captured into a law enforcement database. The relationships between the law-enforcement effort and encounters with illegal activity and wildlife assume that patrol reports are reliable accounts of the activities of the patrol staff, both in terms of technical precision and in terms of being a true account of events (Jachmann 2008a). The law enforcement data for Gonarezhou showed that the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) recruited additional patrol rangers in the year 2004. Furthermore, data on large herbivore population estimates for the northern Gonarezhou (i.e., Chipinda Pools, Chilojo A and Chilojo B aerial survey strata), for 2001 and 2009, were extracted from past aerial survey reports (Dunham 2002; Dunham et al. 2010).

Data analysis

Chi-square (χ^2) tests for goodness-of-fit were used to test whether responses on the prevalence of illegal hunting, perceived illegal hunting trends and protection given by the government to wildlife between 2000 and 2010 were different among the 236 respondents using SPSS version 19 for Windows (SPSS Inc., Chicago, USA). We used the response categories outlined in Table 1 in the Chi-square tests. Cross-tabulation with gamma (G) test were used to establish the association between responses on: (i) prevalence of illegal hunting and perceived illegal hunting trends; (ii) prevalence of illegal hunting and protection given by government to wildlife; and (iii) perceived illegal hunting trends and protection given by government to wildlife. We further examined trends in law enforcement performance and illegal activities in northern Gonarezhou from 2000 to 2010 to reveal patterns during the period of political instability and economic collapse. Law enforcement performance was evaluated using two measures, namely (i) effective patrol staff density (i.e., number of patrol rangers per km^2) and (ii) effective patrol days/staff/month derived from effective patrol man-days (Jachmann 2008a, b). For the northern Gonarezhou, the only readily available patrol data were from long or extended patrols. Effective patrol days for long patrols in northern Gonarezhou are indirectly measured by the patrol nights spent by each ranger. Effective patrol time was standardised and converted directly from patrol nights to effective patrol days which were later converted to effective patrol days/staff/month. We examined whether law enforcement performance and illegal activities differed in the two periods, i.e., 2000–2003 and 2004–2010 following the recruitment of more patrol staff in northern Gonarezhou in 2004, using independent samples two-tailed *t*-tests with unequal sizes.

In order to assess the overall effect of law enforcement performance on illegal activities between 2000 and 2010 in northern Gonarezhou, we used repeated measures analysis of variance (ANOVA), with law enforcement performance and time (year) as

independent variables and illegal activities (hunting and fishing) as dependent variables. Data on effective patrol staff density, arrested bushmeat hunters and fish poachers were $\log_{10}(x + 1)$ transformed to meet the normality requirements of ANOVA tests. Furthermore, for common large herbivore species in northern Gonarezhou, we calculated percentage population size changes using population estimate data from 2001 to 2009 in order to determine whether animal populations were increasing, decreasing or remained the same.

Results

Perceptions of illegal hunting in northern Gonarezhou between 2000 and 2010

Responses on perceptions of illegal hunting trends between 2000 and 2010 varied among the 236 respondents ($\chi^2 = 114.14$, df = 2, $P < 0.0001$). A higher proportion of the respondents ($n = 156$, 66%) perceived that illegal hunting activities had declined whereas 18% ($n = 42$) of the respondents perceived that illegal hunting activities had increased and 16% ($n = 38$) of the respondents perceived that illegal hunting activities had remained the same in the study area between 2000 and 2010. The main reasons for the perceived decline in illegal hunting were reported to include; (i) that poachers were afraid of being arrested or imprisoned due to strengthened law enforcement ($n = 173$, 73%), (ii) the positive impact of conservation awareness and educational programmes ($n = 62$, 26%), and (iii) few firearms were available for use in illegal hunting ($n = 8$, 3%).

Similarly, responses on the frequency of sighting illegally hunted animals and/or bushmeat being traded in the villages between 2000 and 2010 varied among the 236 respondents ($\chi^2 = 15.31$, df = 2, $P < 0.001$). A higher proportion of the respondents ($n = 107$, 45%) reported that they had sighted illegal hunted animals or bushmeat being traded at least once over six months whereas 28% ($n = 65$) and 27% ($n = 64$) of the respondents reported that they had sighted illegal hunted animals or bushmeat being traded at least once between 31 and

180 days, and once in a month respectively. There was a significant relationship between responses on the frequency of sighting illegally hunted animals and/or bushmeat being traded and the perceived illegal hunting trends (gamma = 0.34, $P = 0.002$).

Animal species hunted and reasons for them being hunted

A total of 26 wild animal species, including large herbivores and carnivores, were reported as being illegally hunted in northern Gonarezhou between 2000 and 2010, with impala, kudu, buffalo, zebra and spotted hyena being the most hunted (Table 2). Respondents highlighted seven reasons why local people were involved in illegal hunting, namely, (i) the need for bushmeat for domestic consumption ($n = 162$, 69%), (ii) local trade in bushmeat in order to raise money ($n = 132$, 56%), (iii) as a way to minimise crop damage ($n = 42$, 18%) and (iv) livestock depredation ($n = 24$, 10%), (v) hunting for traditional reasons ($n = 24$, 10%), (vi) unemployment ($n = 10$, 4%), and (vii) hunting as a hobby ($n = 7$, 3%).

Perceptions by locals of protection given to wildlife by the government

About 46% ($n = 108$) of the total respondents perceived that protection given by the government to wildlife had increased between 2000 and 2010 in northern Gonarezhou whereas 37% ($n = 88$) and 17% ($n = 40$) of the respondents perceived that protection given by government to wildlife had remained the same and decreased respectively. These responses significantly varied among the 236 respondents ($\chi^2 = 31.05$, df = 2, $P < 0.0001$). However, the relationship between responses on the frequency of sighting illegally hunted animals and/or bushmeat being traded and protection given by government to wildlife was not significant (gamma = 0.07, $P = 0.455$). In contrast, there was a significant relationship between responses on the perceived illegal hunting trends and protection given by government to wildlife (gamma = 0.23, $P = 0.028$).

Table 2. Animal species reported to be commonly hunted illegally in northern Gonarezhou National Park and adjacent areas, Zimbabwe, between 2000 and 2010. Total percentage exceeds 100 because the respondents were allowed to give multiple answers.

Common name	Scientific name	Number of responses	Percentage (%)
Impala	*Aepyceros melampus*	126	53
Kudu	*Tragelaphus strepsiceros*	119	50
Buffalo	*Syncerus caffer*	110	47
Zebra	*Equus quagga*	81	34
Spotted hyena	*Crocuta crocuta*	77	32
Wildebeest	*Connochaetes taurinus*	57	24
Elephant[V]	*Loxodonta africana*	46	19
Warthog	*Phacochoerus africanus*	45	19
Leopard[NT]	*Panthera pardus*	42	18
Eland	*Taurotragus oryx*	40	17
Lion[V]	*Panthera leo*	31	13
Common duiker	*Sylvicapra grimmia*	20	9
Waterbuck	*Kobus ellipsiprymnus*	20	9
Giraffe	*Giraffa camelopardalis*	20	9
Nyala	*Tragelaphus angasii*	19	8
Bushbuck	*Tragelaphus scriptus*	19	8
Cheetah[V]	*Acinonyx jubatus*	17	7
Steenbok	*Raphicerus campestris*	14	6
Reedbuck	*Redunca redunca*	12	5
Baboon	*Papio ursinus*	11	5
Hippopotamus[V]	*Hippopotamus amphibius*	11	5
Nile crocodile[LR]	*Crocodylus niloticus*	10	4
Klipspringer	*Oreotragus oreotragus*	10	4
Sable	*Hippotragus niger*	8	3
Common genet	*Genetta genetta*	5	2
Porcupine	*Hystrix cristata*	2	1

Notes: Species categorised as Vulnerable: V, Lower Risk: LR and Near-Threatened: NT on the 2011 IUCN (International Union for the Conservation of Nature) Red List (IUCN 2012).

Law enforcement performance from law enforcement data

In 2000, a total of 18 patrol rangers were stationed at Chipinda Pools, northern Gonarezhou translating to 0.006 effective patrol staff/km^2 (Fig. 2a). The number of patrol rangers increased to 51 in 2004 following the recruitments of new rangers (0.017 effective patrol staff/km^2) and by end of December 2010, there were 38 patrol rangers in Chipinda Pools (0.013 effective patrol staff/km^2; Fig. 2a). The mean number of effective patrol staff/km^2 was significantly higher for the period 2004–2010 (mean and standard error: 0.014 ± 0.001) compared to 2000–2003 (0.005 ± 0.0004) (t = –10.74, df = 9, P < 0.0001). The slight decline in available patrol rangers in Chipinda Pools between 2004 and 2010 was a result of transfers, resignations, retirements and/or natural deaths. Data for patrol days were unavailable for the period 2000–2003. In 2004, staff performance was 3.0 effective patrol days/staff/month but it gradually improved to 7.4 effective days/staff/month in 2010 (mean = 5.59 ± 0.71). The high peak in 2005 coincides with an increase in patrol rangers and patrols in northern Gonarezhou (Fig. 2b).

Illegal activities recorded from law enforcement patrols

A total of 940 illegal hunters and 1509 illegal fish poachers were captured, 79 hunting dogs were shot and 7340 wire snares were recovered between 2000 and 2010 in northern Gonarezhou. Illegal activities, mainly illegal fishing and hunting, in the northern Gonarezhou were high between 2000 and 2003, and declined towards 2010 (Figs. 2c and d). The peak in hunter and illegal fisher arrests in 2002 was associated with increased patrols following human settlement encroachments within the north-western Gonarezhou. The mean number of illegal hunters arrested were significantly lower for the period 2004–2010 (53 ± 14) compared to the period 2000–2003 (191 ± 67) (t = 3.03, df = 8, P = 0.016). The mean number of illegal fish poachers arrested did not differ significantly between the period 2000–2003 (211 ± 104)

and 2004–2010 (95 ± 17) (t = 1.47, df = 9, P = 0.176). The mean number of wire snares recovered did not differ between the period 2000–2003 (628 ± 111) and 2004–2010 (896 ± 160) (t = –0.76, df = 7, P = 0.474; Fig. 2e). Data for number of dogs shot were unavailable for the period 2000–2003. Four dogs were shot in 2004 and this increased to 21 in 2010 (Fig. 2f). The repeated-measures ANOVA results, with a Greenhouse-Geisser epsilon correction for lack of sphericity in the variance–covariance matrix, indicated no significant illegal activities × year ($F_{1,3.001}$ = 1.61, P = 0.293), illegal activities × effective patrol days/staff/month ($F_{1,3.001}$ = 0.95, P = 0.403) or illegal activities × effective staff density/km^2 ($F_{1,3.001}$ = 0.62, P = 0.488) interactions between 2000 and 2010.

About 499 animals of 22 species were illegally killed between January 2001 and December 2010 (Table 3). Patrol reports showed that most animals were killed by snaring using steel cables from the old cattle veterinary fence, stolen telephone and electricity overhead cables, and old boundary fence. Other hunting methods recorded were using bow and arrows, hunting dogs, firearms mostly for elephant, and poisoning. Impala, kudu and elephant were the most common illegally hunted animals in northern Gonarezhou between 2001 and 2010. Large carnivores, namely lion and spotted hyenas were amongst the least illegally killed species. Overall, only 20 animal species were common among the reportedly illegally hunted animals and those that were recorded to have been illegally hunted. Differences in the recorded illegally killed animals and animals perceived to be commonly hunted illegally (Table 2) in northern Gonarezhou include four animal species (bushbuck, reedbuck, klipspringer and sable) that were not recorded among the illegally hunted animals. In addition, two animal species (Sharpe's Grysbok and slender mongoose) that were recorded as illegally hunted were not reported to be illegally hunted.

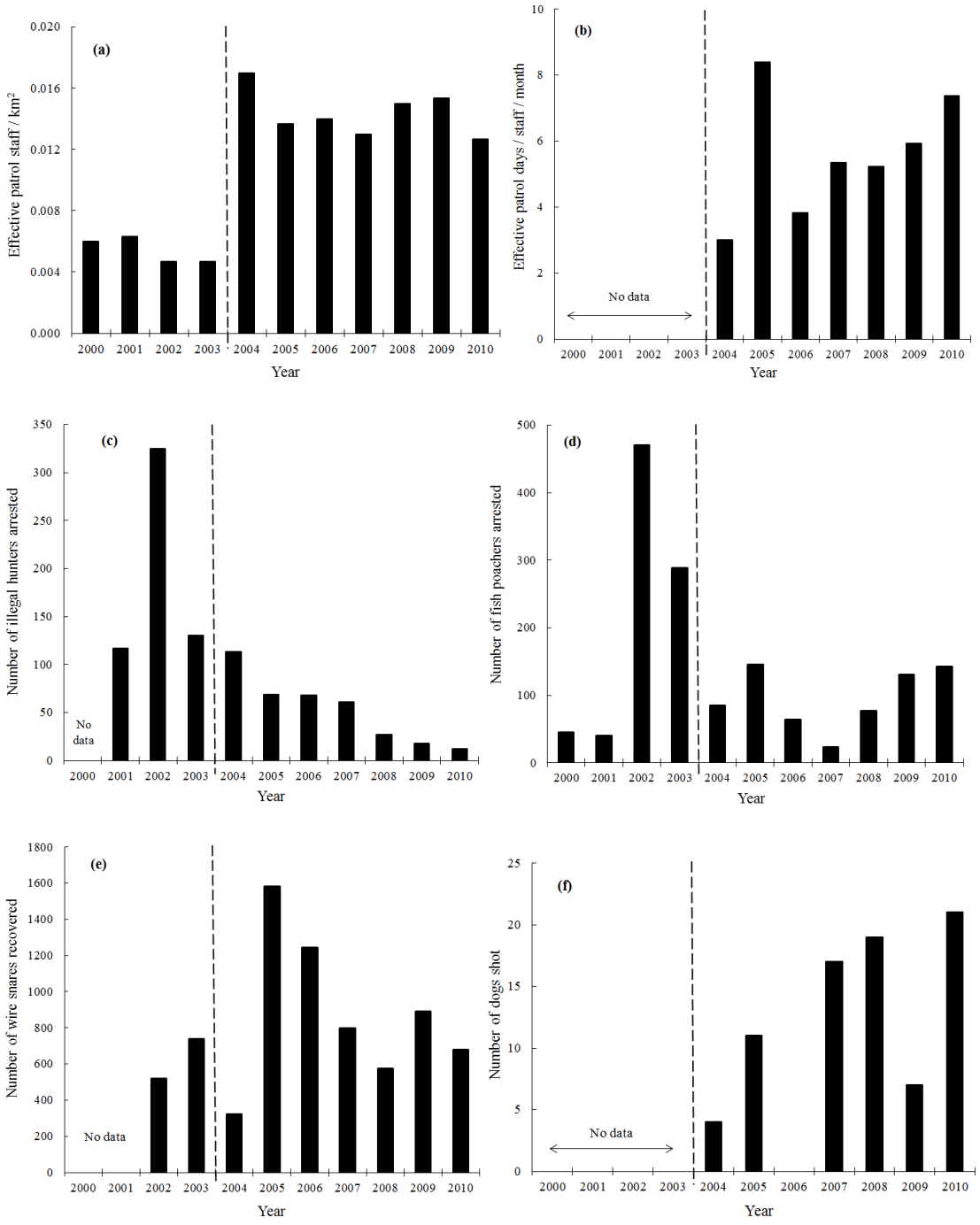

Fig. 2. Trends in law enforcement performance and recorded illegal activities in Chipinda Pools, northern Gonarezhou National Park, Zimbabwe, from January 2000 to December 2010. *Notes*: Dashed vertical lines separate the period before and after recruitments of patrol rangers.

Despite the illegal hunting of primarily large herbivores in the northern Gonarezhou, most of the large herbivores showed increasing populations sizes between 2001 and 2009. Nyala (+727%), eland (+269%), zebra (+126%) and elephant (+111%) were amongst the species with the highest population size increases (Table 4).

Table 3. Animals recorded lost to illegal hunting in Chipinda Pools, northern Gonarezhou National Park, Zimbabwe, from January 2001 to December 2010, based on law enforcement data. *Notes*: BW – bow and arrow, F – fire arm, HD – hunting dog, P – Poison, and S – snare.

Common name	Scientific name	Total killed	Hunting method used
Impala	*Aepyceros melampus*	194	S/HD
Kudu	*Tragelaphus strepsiceros*	58	S/HD
Elephant[V]	*Loxodonta africana*	54	F/S
Nyala	*Tragelaphus angasii*	31	S/HD
Zebra	*Equus quagga*	27	S
Warthog	*Phacochoerus africanus*	21	S/HD
Eland	*Taurotragus oryx*	18	S
Buffalo	*Syncerus caffer*	16	S
Wildebeest	*Connochaetes taurinus*	13	S
Common duiker	*Sylvicapra grimmia*	11	S/HD
Waterbuck	*Kobus ellipsiprymnus*	11	S/HD
Giraffe	*Giraffa camelopardalis*	9	S
Steenbok	*Raphicerus campestris*	7	S/HD
Baboon	*Papio ursinus*	6	HD
Sharpe's Grysbok	*Raphicerus sharpie*	5	S/HD
Hippopotamus[V]	*Hippopotamus amphibius*	5	P
Spotted hyena	*Crocuta crocuta*	3	P
Porcupine	*Hystrix cristata*	3	BW
Nile crocodile[LR]	*Crocodylus niloticus*	2	P
Lion[V]	*Panthera leo*	2	S
Slender mongoose	*Galerella sanguine*	2	HD
Common genet	*Genetta genetta*	1	HD
Total	–	499	–

Notes: Species categorised as Vulnerable: V and Lower Risk: LR on the 2011 IUCN Red List (IUCN 2012).

Table 4. Estimated population sizes (± standard errors) and percentage change in common wild animals between 2001 and 2009 in northern Gonarezhou National Park, Zimbabwe. *Notes*: n.a. – not available; dash (–) denotes not applicable.

Common name	2001	2009	Percentage change (%)
Nyala	37 ± 12	306 ± 49	+727
Eland	74 ± 25	273 ± 84	+269
Zebra	286 ± 84	647 ± 109	+126
Elephant	2628 ± 441	5543 ± 386	+111
Waterbuck	168 ± 50	326 ± 109	+94
Kudu	889 ± 166	1445 ± 337	+63
Giraffe	60 ± 12	95 ± 21	+58
Impala	2432 ± 294	3660 ± 630	+50
Buffalo	919 ± 216	1163 ± 337	+27
Wildebeest	n.a.	266 ± 51	–

Source: Dunham (2002) and Dunham et al. (2010).

Discussion

Local people near protected areas in tropical ecosystems adapt to disturbances or hardships caused by economic collapse, social unrest, military or political conflict through migration or diversifying income, including illegal fishing and hunting (Draulans & Van Krunkelsven 2002; Yamagiwa 2003; Fusari & Carpaneto 2006; De Merode et al. 2007; Beyers et al. 2011; Brashares et al. 2011).Contrary to perceived collapse of wildlife management systems in Zimbabwe since 2000 (Shaw 2008), our results show that law enforcement performance was strengthened in 2004 in the northern Gonarezhou which could have resulted in the overall

perceived decline in illegal activities by the study respondents. The then Department of National Parks and Wildlife Management was transformed into a parastatal, namely ZPWMA starting in 2000 following the amendment of Zimbabwe's *Parks and Wildlife Act* (1975) with full implementation in 2002 (Mtsambiwa 2003). This transformation resulted in a direct increase in funds available for wildlife management since income generated by the ZPWMA no longer went to the central government but was directly channelled to conservation (Mtsambiwa 2003). Sport-hunting has been the major revenue source for the ZPWMA and other local conservation areas. Surprisingly, sport-hunting was not severely affected by the political instability and economic decline in Zimbabwe (Balint & Mashinya 2006; Lindsey et al. 2009a). Consequently, ZPWMA was able to enhance wildlife protection in the northern Gonarezhou by increasing the number of patrol rangers in 2004 (from 18 to 51 rangers). However, in terms of personnel, the coverage area per ranger in 2010, i.e., one ranger for every 79 km^2 of protected area, is far higher than the recommended minimum of one park ranger for every 24 km^2 of protected area if effective patrolling and policing is to be realised (Jachmann & Billiouw 1997). Furthermore, anti-poaching efforts in the northern Gonarezhou were also strengthened by the involvement of the Frankfurt Zoological Society in the management of the park since October 2007, which led to more resources being made available for law enforcement activities. The recurrent expenditure for law enforcement in northern Gonarezhou rose from USD 52 per km^2 annually in 2000 to USD 250 per km^2 annually in 2010. The increase in law enforcement expenditure is above the minimum range of expenditure estimated to be between USD 50 and 200 per km^2 annually that wildlife agencies in Africa need to protect large herbivores, in particular elephant, in their natural ranges (Jachmann & Billiouw 1997).

We recorded that illegal hunters hunted a wide range of animal species in this study. Out of the 26 animal species reported as being illegally hunted, 20 animal species were

recorded as having been illegally killed in Gonarezhou. Differences in the number of animal species mostly illegally hunted likely come from the fact that most of the animal species that were not recorded as illegally hunted are small herbivores, which are difficult to detect when illegally hunted. Our study shows that small to medium body sized animals, for example impala, were the most illegally hunted species. Subsistence hunting is primarily targeted at small-bodied species like impala with large-bodied animals such as elephants targeted for their trophies such as ivory. Some of the illegally hunted species in the northern Gonarezhou are of conservation concern: crocodile is classified as lower risk; elephant, lion, cheetah, hippopotamus are classified as vulnerable, and leopard is classified as near threatened on the IUCN Red List (IUCN 2012). Using a vulnerability classification approach based on species vulnerability to decline and extinction involving opinions from international and local experts, Van der Hoeven (2007) categorised leopard as least concern, buffalo as lower risk and elephant as vulnerable. The differences in these two vulnerability classifications points to the need for more detailed local assessments for animal species that allows the setting of appropriate local level conservation priorities (Van der Hoeven 2007).

Hunting for wild animals in the northern Gonarezhou is, just like in other regions across the globe, stimulated by the need to meet nutritional, economic, cultural and recreational requirements (Hofer et al. 2000; Rao et al. 2005; Grey-Ross et al. 2010; Brashares et al. 2011; Golden et al. 2011; Wilkie et al. 2011; Bitanyi et al. 2012). Subsistence hunting is done mainly for domestic consumption or for selling within the community (Gandiwa 2011). The reasons given for illegal hunting in the present study suggest that the main drivers of bushmeat hunting and trade include need for bushmeat, money and unemployment. Our study contributes to the increasing evidence for illegal hunting in protected areas throughout Africa for the bushmeat trade, particularly in southern Africa.

Our results show that with increased illegal hunter's arrests, there was a shift to snaring as more wire snares were recovered by law enforcement staff. Snares are regarded as the simplest and most effective hunting devices (Hurt & Ravn 2000; Jachmann 2008b; Fa & Brown 2009). It has been suggested that, with increased law enforcement efforts in an area, illegal hunters were likely to switch to less detectable methods such as snaring, and target smaller sized mammals such as impala (Gibson & Marks 1995). Elsewhere, in the Serengeti National Park, Tanzania, illegal hunters were reported to use a variety of hunting methods with snaring being the common hunting method (Hurt & Ravn 2000; Nyahongo et al. 2005; Holmern et al. 2007). However, in areas outside the Serengeti National Park, where law enforcement was regarded as low, hunters were reported to actively stalk their prey (Holmern et al. 2006) and use other hunting methods such as guns, spears, and bow and arrows. Furthermore, Ngurdoto Crater, which was nearly as rich in wildlife as Ngorongoro Crater, also in Tanzania, lost its wildlife due to illegal hunting with dogs that were kept in underground pens to prevent discovery in the 1970s and 1980s (H.H.T. Prins, *personal observation*).

Our results using law enforcement and large herbivore population data from the northern Gonarezhou suggest that pressure from illegal hunting is light as some large herbivore populations increased in population sizes between 2001 and 2009 despite a total of approximately 500 wild animals having been illegal hunted between 2000 and 2010, and also the recorded human settlement encroachments in a small portion of north-western Gonarezhou (Mombeshora & Le Bel 2009; Gandiwa et al. 2011). In contrast, it has been reported that most wildlife population declines following the political instability and economic decline in Zimbabwe since 2000 were recorded on private game ranches or farms following widespread poaching associated with the land invasions and collapse of law enforcement systems in some areas (Chaumba et al. 2003a; Wels 2003; Wolmer 2005;

Degeorges & Reilly 2007; Williams 2011). Elsewhere, in much of tropical rainforest ecosystems populations of many large bodied wildlife species have already declined or were extirpated because of habitat loss and hunting, leaving a fauna consisting predominantly of resilient, rapidly reproducing species (Peres 2000, 2001; Barnes 2002; Bennett et al. 2007; Van der Hoeven 2007; Harrison 2011; Wilkie et al. 2011). Therefore, evaluating the sustainability of hunting is key to the conservation of species exploited for bushmeat (Milner-Gulland & Akçakaya 2001; Ling & Milner-Gulland 2006). Because large body size is correlated with slow breeding, large animals would be more susceptible to extinction under any environmental or anthropogenic impact that targeted slow breeders (Koch & Barnosky 2006).

Although there was an economic collapse in Zimbabwe (Coltart 2008), the country fell back to a subsistence economy, in which there was only limited violence and no refugees, and this may have prevented an increase in illegal hunting over the study period. Furthermore, remittances from those who had migrated outside of Zimbabwe played an important role in the day-to-day survival of local people (Makina 2013) and could also have eased the demand for trade in bushmeat to raise income. Similarly, the emigration of local people living adjacent to the Gonarezhou to neighbouring countries, mostly South Africa and Mozambique, to look for employment and/or to commercial farms under the land reform programme could have led to a decline in illegal hunting pressure in Gonarezhou. Elsewhere, in the Central African Republic (Blom et al. 2005), Democratic Republic of Congo (Draulans & Van Krunkelsven 2002; Yamagiwa 2003; Beyers et al. 2011), and Rwanda (Kanyamibwa 1998), human conflicts such as civil wars and economic collapse led to substantial negative impacts on wildlife and conservation, resulting in significant losses of wildlife due to institutional collapse, lawlessness and uncontrolled exploitation of natural resources such as bushmeat.

Our study shows that political instability and economic collapse do not necessarily lead to increased hunting in situations where policy instruments, such as law, are enforced. In addition, increasing law enforcement helped minimise the level of illegal hunting in Gonarezhou. Therefore, over an 11-year period (i.e., 2000–2010), our study does not support the first hypothesis that illegal hunting activities would be increased due to economic collapse. However, our results showed that in the initial phase, i.e., 2000–2003, we did see a reduction in law enforcement and when law enforcement increased in 2004, illegal hunting activities, particularly the number of arrested bushmeat hunters, decreased. These changes in the levels of illegal hunting activities and law enforcement efforts partly supports the second hypothesis that illegal hunting activities would vary with law enforcement efforts. Hence, effective enforcement of wildlife laws is important for the conservation of wildlife resources (Bruner et al. 2001; Rowcliffe et al. 2004; Holmern et al. 2007; Keane et al. 2008). Our study showed that snaring appeared to be one of the common hunting methods in the northern Gonarezhou. Snares could therefore be collected more effectively if there is a ranger team specialising in snare search patrols (Wato et al. 2006). Therefore, there is need for the ZPWMA to increase its ranger staffing levels to allow for effective patrolling and policing of the northern Gonarezhou to be realised.

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CHAPTER 4: CAMPFIRE and human-wildlife conflicts in local communities bordering northern Gonarezhou National Park, Zimbabwe*

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Abstract

Human-wildlife conflicts are a global problem, and are occurring in many countries where human and wildlife requirements overlap. Conflicts are particularly common near protected areas where societal unrest is large. To ease conflict, integrated conservation and development projects (ICDPs) have been implemented. The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) is an example of an ICDP. We hypothesised that (i) a higher perceived effectiveness of CAMPFIRE would be associated with a decline in human-wildlife conflicts, and (ii) local communities with higher perceived effectiveness of CAMPFIRE programs would have more favourable attitudes towards problematic wild animals. Four focus group discussions and interviews with 236 respondents were conducted in four local communities adjacent to northern Gonarezhou National Park, Zimbabwe from December 2010 to August 2011. Moreover, we included data on recorded incidences of human-wildlife conflicts and CAMPFIRE financial returns to study communities between 2000 and 2010. Our results indicate that local communities show considerable differences in how CAMPFIRE effectiveness was perceived. Local communities with higher ratings of CAMPFIRE effectiveness generally perceived a decline in human-wildlife conflicts, although some people had experienced problems with wild animals. Attitudes towards main problematic wild animals varied across the study communities and were partly associated with perceived CAMPFIRE effectiveness. Our findings partly support both of our study hypotheses. Contextual factors across the four local communities seemed to influence the perceived effectiveness of CAMPFIRE programs and attitudes towards problematic wildlife species. We recommend that decisions and actions regarding the control of problem animals be devolved to the community level in order to help reduce human-wildlife conflicts in community-based natural resources management programs.

Keywords: Attitudes; benefits; human-wildlife conflicts; integrated conservation and development projects; perception; protected areas

Introduction

Human-wildlife conflicts are a global problem, and are occurring in many countries where human and wildlife requirements overlap (Deodatus 2000; Dickman 2010; Hoffman & O'Riain 2012). Conflicts between people and wildlife are encountered by a diverse group of communities, particularly those residing close to protected areas containing large to very large herbivores (buffalo, hippopotamus, rhino and elephant) and large carnivores (Newmark et al. 1994; Hemson et al. 2009). Human-wildlife conflicts are contentious because the resources concerned have a considerable economic value for local residents, while wildlife species have both national and international value, and are legally protected (Mayaka 2002). Human-wildlife conflicts can take various forms, including carnivores attacking and killing livestock or humans, species raiding crops, competition for game and/or resources, disease exchange between livestock and wildlife, carcass poisoning, and retaliation killing (Thirgood et al. 2005; Madden 2008). The conflict involves a variety of mammals, birds, fish, insects, and reptiles (Manfredo & Dayer 2004).

Human-wildlife conflicts have escalated because of (i) changes in land-use, arable farming and sedentary life style of pastoralists, (ii) inadequate wildlife control, and (iii) bans on hunting of some wild animals (Prins & Grootenhuis 2000). For instance, in Africa, a large proportion of the human population is dependent on the land for their (economic) well-being. Together with the presence of many species of large mammals, this leads to a high density of conflict between people and wildlife (De Boer & Baquete 1998). This, in turn, creates friction between managers of protected areas and local communities living in regions that border these protected areas. Consequently, the resulting human-wildlife conflicts often undermine local support for conservation (e.g., Gusset et al. 2009).

Crop-raiding by large herbivores and livestock depredation by carnivores can reduce tolerance toward species that are already threatened, whereas potential dangers posed by conflicts with large-bodied wild animal species may also negatively influence local attitudes towards animals (Browne-Nuñez & Jonker 2008). Perceptions about problems and attitudes towards conservation and/or animals are likely to be influenced by social interests and experienced costs and benefits (Leeuwis & van den Ban 2004). Studies of rural communities in developing countries have found that access to conservation-related benefits and involvement of local people in decision-making for resource management can positively influence local attitudes towards wildlife, protected areas and conservation (Gillingham & Lee 1999; Treves et al. 2009).

Biodiversity conservation has been dominated by two paradigms, namely, the protectionist approach and community conservation approach. The protectionist approach, also known as fortress conservation, involves the creation of protected areas, uses of fences and fines, the exclusion of people and domestic livestock, prevention of consumptive use and minimisation of other forms of human impact to ensure pristine environments or existence of wilderness areas (Oates 1999; Terborgh 1999; Hutton et al. 2005). Historically, most protected areas have been created using the protectionist approach. The major arguments for strict protection include that protected areas are important in maintaining ecological structure and function, and that many species, especially large mammals, need extensive, undisturbed tracts of habitat to ensure their survival (Wilshusen et al. 2002). The protectionist approach has been reported to have succeeded at several places but at a high social cost and conflict, especially in developing countries (Lele et al. 2010). Thus, by the 1980s and 1990s, the protectionist approach was progressively challenged by a new community conservation approach after wide discussions were held on the negative impacts of protected areas on local people (Brechin et al. 2002; Brockington & Schmidt-Soltau 2004). It has been reported that

strict protection in some cases has failed to consider other important factors, including social, cultural, and political issues, which has resulted in difficulties in enforcing conservation policies (Andrade & Rhodes 2012). One such challenge is human-wildlife conflicts. Hence, community conservation approaches stressed the need to ensure the involvement and participation of local people in biodiversity conservation in areas with protected areas (Hutton et al. 2005; Brockington et al. 2008).

Many conservation agencies have sought to gain local support by promoting community-based conservation programs (Prins et al. 2000). These community-based conservation interventions take a variety of forms, from community outreach to integrated conservation and development projects (ICDPs) in which development and conservation goals of people living in and around protected areas, particularly in developing countries, are equally prioritized (Barrett & Arcese 1995; Romero et al. 2012). ICDPs aim to achieve medium-term solutions to local conflicts between biological conservation and natural resource use in economically poor and remote areas (Johannesen 2006). Consequently, improving the well-being of local communities as a means to alleviate the human pressures responsible for ecosystem degradation has been a central assumption of such approaches (Barrett & Arcese 1995). Available evidence, however, suggests that ICDPs are not fully effective in protecting biodiversity due to challenges in deriving meaningful local economic benefits from protected areas that lack tourism potential, and due to the mismatch between location of costs and benefits of conservation, illegal resource exploitation, and limitations in designs, which fail to capture the highly complex and heterogeneous characteristics of local communities and geo-political realities (Brown 2002; Garnett et al. 2007).

Sustainable development practices of ICDPs include those that provide direct incentives for conservation of biodiversity through the harvest of animal or plant resources that are dependent upon natural habitats in and/or adjacent to protected areas (Hurt & Ravn

2000). The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) launched in Zimbabwe, on communal areas adjacent to national parks, was considered as one of the key initiatives adopted to ensure that there was no conflict between the economic survival of agricultural communities and foraging needs of wildlife (Wolmer et al. 2004) while generating benefits, promoting conservation, and empowering local communities (Child 2000; Murphree 2009). The CAMPFIRE concept was instrumental in instilling pride and conservation on communally owned lands in Zimbabwe (Heitkönig & Prins 2009) while at the same time creating opportunities for employment and infrastructural development (Mutandwa & Gadzirayi 2007).

Previous studies have reported that successful or effective community-based natural resources management programs, such as CAMPFIRE, would be associated with reduced human-wildlife conflicts as a result of (i) the devolution of wildlife management to local people; (ii) a high response to incidences of human-wildlife conflicts, which would mitigate wildlife-induced damages in the community; and (iii) the high education and environmental awareness of local people on how to minimise risk or damage from wild animals (e.g., Woodroffe et al. 2005; Mapedza & Bond 2006). However, in certain cases where human-wildlife conflicts were on the rise due to increasing animal populations and unsatisfactory response by responsible authorities, human-wildlife conflicts have been reported as undermining what have been, to date, quite successful CAMPFIRE programs (Mutandwa & Gadzirayi 2007), given that the *Parks and Wildlife Act* of 1975, Zimbabwe, does not have provisions for direct compensation for losses from wildlife. Therefore, increases in wildlife populations, particularly large herbivores and carnivores, as a result of conservation programs have been reported to result in increased human-wildlife conflicts (Le Bel et al. 2011). Human population increases adjacent to protected areas and the resultant encroachments into protected areas, and increasing livestock populations have also been reported to result in

increases in human-wildlife conflicts (Lamarque et al. 2009). Furthermore, political instability and land reforms in some wildlife areas have been linked to increases in human-wildlife conflicts (Le Bel et al. 2011).

To date, there has been little research on human-wildlife conflicts that takes into consideration the effectiveness of CAMPFIRE programs (Mutandwa & Gadzirayi 2007). We focus on how effective the CAMPFIRE program is in the eyes of its participants, how this relates to perceived human-wildlife conflicts, and what are the resultant attitudes towards wild animals. The objectives of this study were to (i) describe the local people's views on the effectiveness of CAMPFIRE programs, (ii) explore the experienced conflicts with wildlife and perceived trends in human-wildlife conflicts, and (iii) determine attitudes of local people towards main problematic wild animals in communities with CAMPFIRE programs. We expected that perceptions of local people on the effectiveness of CAMPFIRE programs, human-wildlife conflicts, and attitude towards problematic wild animals would generally vary across the study communities due to the contextual differences among communities. More specifically, we hypothesised that (i) a higher perceived effectiveness of CAMPFIRE would be associated with a decline in human-wildlife conflicts, and (ii) local communities with higher perceived effectiveness of CAMPFIRE programs would have more favourable attitudes towards problematic wild animals.

Methods

Study area

We focussed on the northern Gonarezhou National Park (hereafter, Gonarezhou) and four adjacent local communities that were implementing CAMPFIRE programs in southern Zimbabwe. The study area was selected based on (i) the existence of local communities with a diverse CAMPFIRE history that were adjacent to a large and unfenced state protected area

(national park), and (ii) the existence of a protected area with a high diversity of large carnivores and herbivores. Gonarezhou was established as a game reserve in the early 1930s but was upgraded to a national park in 1975 under the *Parks and Wild Life Act* of 1975. Gonarezhou and the surrounding areas have been part of the Great Limpopo Transfrontier Conservation Area since 2000. Gonarezhou covers an area of ~5050 km^2, and is located between 21° 00′–22° 15′ S and 30° 15′–32° 30′ E. Four local communities adjacent to the northern Gonarezhou, namely Chibwedziva and Chizvirizvi in the Chiredzi district, and Mahenye and Mtandahwe in the Chipinge district, were selected (Fig. 1). Within the four selected communities, eight study villages out of 82 villages were randomly selected for data collection (Table 1). Within the eight villages, we controlled for the same culture, language and economic development.

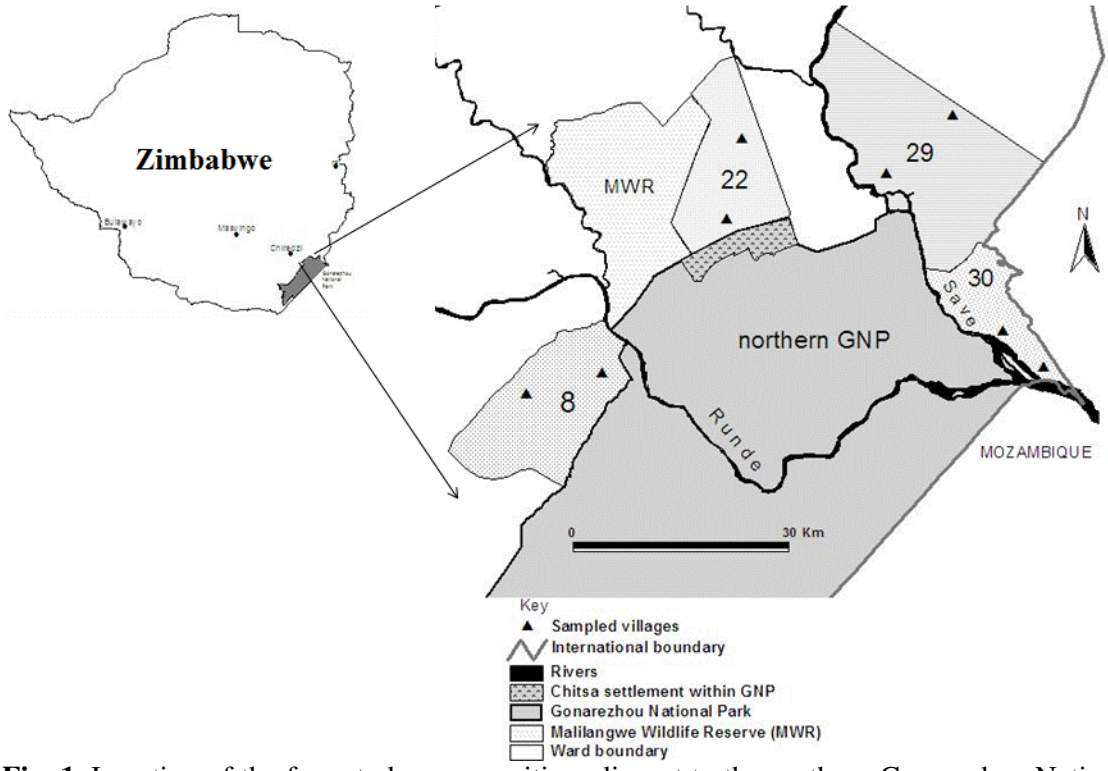

Fig. 1. Location of the four study communities adjacent to the northern Gonarezhou National Park (GNP), southeastern Zimbabwe. *Notes*: 8–Chibwedziva, 22–Chizvirizvi, 29–Mtandahwe and 30–Mahenye.

Table 1. General characteristics of the four study communities adjacent to the northern Gonarezhou National Park (GNP), Zimbabwe. *Source*: Hlambela and Kozanayi (2005), Mashinya (2007) and Dunham et al. (2010).

Attributes	Community			
	Chibwedziva	Chizvirizvi	Mtandahwe	Mahenye
District	Chiredzi	Chiredzi	Chipinge	Chipinge
Ward number	8	22	29	30
Land status	Communal area	Resettlement area	Communal area	Communal area
Location	Northwest of the GNP	Northwest of the GNP	North of the GNP	North of the GNP
Area (km^2)	350	250	500	200
Human population	11,300	3,000	11,400	3,500
Chief	Chief Sengwe	Chief Tshovani	Chief Garahwa	Chief Mahenye
Elephant density (km^{-2}) in the area bordering GNP	2.4	2.2	2.2	2.2
Appropriate Authority granted	1993	2003	1991	1991
CAMPFIRE tourism infrastructure	No hotel/lodges	No hotel/lodges	No hotel/lodges	Hotel/lodges
Study villages	Chihosi and Chipachani	Village 5 and Village 6	Maparadze and Matunga	Mudavanhu and Tongogara A

The study area lies in a semi-arid savanna ecosystem and supports a wide variety of large herbivore species, including elephant (*Loxodonta africana*), hippopotamus (*Hippopotamus amphibius*), buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), plains zebra (*Equus quagga*), waterbuck (*Kobus ellipsiprymnus*) and wildebeest (*Connochaetes taurinus*). Gonarezhou also has a variety of large carnivores, including lion (*Panthera leo*), leopard (*Panthera pardus*) and spotted hyena (*Crocuta crocuta*). Local residents in communities adjacent to Gonarezhou practice a combination of subsistence, cash crop farming and livestock production (Hlambela & Kozanayi 2005). The main crops include sorghum (*Sorghum bicolor*) and maize (*Zea mays*), grown for both subsistence utilisation and commercial sale, and cotton (*Gossypium* spp.), specifically grown for commercial sale.

Livestock include cattle (*Bos taurus*), goats (*Capra hircus*), sheep (*Ovis aries*), donkeys (*Equus asinus*), and poultry. The dominant ethnic group in the study area is Shangaan.

Administrative structure of CAMPFIRE

CAMPFIRE is a government initiative that was designed specifically to stimulate long-term development, management, and sustainable use of natural resources in Zimbabwe's communal farming areas (Martin 1986). Communal areas in Zimbabwe are divided into administrative units of villages. Six or seven villages make a ward or community (Madzudzo 1997). The philosophy of CAMPFIRE initiatives is that local communities need to realise commercial benefits in order for them to sustainably manage local natural resources (Mapedza 2009). This philosophy attempts to link the costs of managing the resource with the benefits derived from the natural resource. CAMPFIRE has been operating in Zimbabwe since 1989, and has largely been restricted to buffer zones adjacent to national parks (Logan & Moseley 2002). CAMPFIRE programs went through a period of intense development during the 1990s and has inevitably suffered from the recent crisis in the country; however, in that first decade, there were some important signs of success but also some considerable difficulties (Fischer et al. 2011). Between 1989 and 2003, CAMPFIRE program was funded by numerous international donors, in particular, the United States Agency for International Development (Mapedza 2009). Funding for CAMPFIRE programs was withdrawn after 2002 following the fast track land reform processes, and this led to local communities relying on money raised from wildlife-based projects in their communities; hence, the decline in benefits accrued (Balint & Mashinya 2006).

In terms of the *Parks and Wild Life Act* of 1975 and amendment of 1982, appropriate authority for the management of wildlife resources in Zimbabwe is conferred to the landowner or occupier of land. Hence, for Chizvirizvi, the appropriate authority for the

utilisation and management of wildlife was conferred to the community or collective resettlement scheme plot holders in the same way that commercial farmers were granted appropriate authorities for their properties. However, in the case of the other three communal areas, appropriate authority for the management of wildlife was conferred to the Rural District Councils (RDCs). The RDCs link with the national government through the provincial government. Most RDCs have entered into contractual arrangements with safari operators who bring hunting clients into CAMPFIRE areas. Revenue generated from wildlife, mainly from safari hunting, is generally distributed as follows: 15% to council as a levy, 35% to council for project management, and 50% to CAMPFIRE communities (Madzudzo 1997). Safari operators pay the hunting fees to RDCs, and RDCs then pass on the community proportion to producer communities through the local CAMPFIRE committees (Mapedza 2009; Taylor 2009). A local CAMPFIRE committee is chaired by an elected chairman, and the committee decides on how the revenues are used in consultation with the local people. However, in some communities, the revenues from wildlife are not large enough to be shared as household dividends (Madzudzo 1997).

Data collection

Effectiveness of CAMPFIRE programs

Data on perceived success or performance of CAMPFIRE programs in four study communities were gathered through focus group discussions following standard procedures (Krueger & Casey 2000). Four semi-structured focus group sessions with residents of Chibwedziva, Chizvirizvi, Mahenye, and Mtandahwe communities were conducted between April and August 2011. Discussants for each focus group in the four study communities were selected from two randomly selected study villages per community (Table 1). In each of the four study communities, a simple random sample of 14 local residents was drawn from a large

pool of 114 respondents who had participated in an earlier survey on perceptions of illegal hunting (Gandiwa 2011). The 114 respondents were randomly selected through picking of numbers from a hat; the numbers corresponded to the households from each of the eight study village registers. Each focus group discussion consisted of 15 people, including one CAMPFIRE representative, per community, giving a total of 60 participants: 37 men and 23 women. CAMPFIRE secretaries of the four study communities were selected for the focus group discussions because they had good knowledge of CAMPFIRE projects. The CAMPFIRE secretaries contributed to the discussions in two ways: (i) by giving general inputs as the other discussants, and (ii) by answering to any specific question about CAMPFIRE. All participants were guaranteed confidentiality. A focus group discussion guide was developed for use by the focus group facilitator, the first author, and included questions designed to gather the ratings of indicators of CAMPFIRE programs' success or performance and responses to human-wildlife conflicts by responsible authorities in the four communities between 2000 and 2010, except for Chizvirizvi, which implemented the CAMPFIRE program only in 2004. Discussions were led by the focus group facilitator and supported by a local research assistant. The local research assistant's task was to translate Shangaan into English in cases where the participant(s) discussed in Shangaan.

We specifically addressed seven topics (i) cash dividends received by local people, (ii) employment opportunities under CAMPFIRE, (iii) infrastructure developments under CAMPFIRE, (iv) involvement of local residents in decision making in CAMPFIRE projects, (v) anti-poaching activities by CAMPFIRE resource monitors, (vi) conservation awareness and education activities, and (vii) local peoples' satisfaction with responses to human-wildlife conflicts by responsible authorities. After a general group discussion on each of the seven topics on CAMPFIRE effectiveness indicators, each discussant was asked to give a rating, independent from other discussants, on a datasheet in the four communities using a five-point

Likert scale (1: strongly unfavourable to 5: strongly favourable). Focus group discussions were conducted during weekdays at appropriate venues in the four communities. Focus group sessions took on average 2.2 hrs to complete (range: 1.4–2.5 hrs).

Experiences with human-wildlife conflicts and attitudes towards problematic animals

Surveys involving a sample of 236 households randomly drawn from each of the eight villages in northern Gonarezhou were conducted from December 2010 to May 2011 to gather data on local people's experiences with human-wildlife conflicts, perceived trends in human-wildlife conflicts, and attitudes towards problematic wild animals. Data were collected from respondents using semi-structured interviews. Current village registers of the eight study villages formed the sampling pool, and households were randomly selected through picking numbers from a hat; the numbers corresponded to the households from each study village register. The household heads were targeted as the respondents. In case of their absence, their wives or another permanently resident adult (≥ 18 years) in the households took part in the interview in his/her residence. The total sample of 236 local residents was comprised of 145 (61%) men and 91 (39%) women. Interviews were conducted conditionally upon the individual's willingness to fully participate.

Pre-testing was conducted in a village occurring in the Chitsa community, outside the study communities to ensure that all questions were clear, and a final version was prepared for sampling. Questions were constructed to seek information on respondent's perceptions of human-wildlife conflicts, and their attitudes towards problematic wild animal species. Human-wildlife conflicts were measured in two ways: (i) actual problems encountered, and (ii) whether respondents perceived that conflicts had increased, decreased, or remained the same between 2000 and 2010. Attitudes towards problematic animals were measured using sentences containing the following construct statement: "Do you 'dislike' the following

animals…?" (Browne-Nuñez & Jonker 2008). Both closed and open questions were included to allow for in-depth discussions of some of the issues raised (Table 2). The wording and ordering of the questions were also carefully thought out to avoid asking leading questions and/or directing the respondent towards particular responses to later questions.

Table 2. Selected survey questions and types of answers.

Questions	Options provided
Did you and your family have problems with wild animals in your village between 2000 and 2010?	Yes/ no
In your opinion, has human-wildlife conflicts within the community increased, decreased or remained the same between 2000 and 2010?	Increased/ decreased/ remained the same
What explains this increase or decrease or no change in conflicts?	Open
What do you do when there are conflicts with wildlife in your village?	Report/ no action/ personal action (e.g., poison, hunt, scare away)
What are the explanations to action you take in cases of conflicts?	Open
Do you dislike each of these five common problematic wild animal species? (elephant, hippopotamus, lion, leopard and spotted hyena)	Yes/no
Why do you dislike these animals?	Open

Interview date was communicated to each selected household one or two days in advance. Upon arrival in each village, a senior member of the village leadership was located, and permission to conduct interviews was sought. Before conducting the interviews, the general purpose of the study was explained. Interviews were conducted with the help of one local research assistant conversant in Shangaan language. The local research assistant had completed secondary school education. To ensure that the information asked was accurate, consistently phrased, and presented in the same way from one interviewee to another, a semi-structured interview guide was used to discuss with the local research assistant to ascertain the question's meaning and wording. Interviews took approximately 45–75 minutes to complete.

Moreover, data on reported incidences of human-wildlife conflicts and revenue received from CAMPFIRE between 2000 and 2010 were collected from Chiredzi Rural District Council (Chibwedziva), CAMPFIRE committees (Mahenye and Mtandahwe) and Lowveld Hunters databases (Chizvirizvi).

Data analysis

Descriptive statistics were used to summarize the property of the focus group discussion and interview response data. The mode as a measure for central tendency and the range to represent the variability in response data were computed for each of the indicator of CAMPFIRE effectiveness for the four communities based on the discussants ratings in the focus groups. Kruskal-Wallis test was used to compare ratings of the CAMPFIRE program's effectiveness across the four communities. We used Chi-square (χ^2) homogeneity tests to determine whether perceptions of experienced conflicts with wildlife, trends of human-wildlife conflicts, measures taken in cases of conflict with wildlife, and attitudes towards problematic animal species were different across the four study communities. Significant differences between community proportions were further tested by the normal deviate (Z) test. Furthermore, we used one-tailed Kendall's tau correlation tests to determine the relationship between the focus group discussants ratings of indicators of CAMPFIRE effectiveness and perceived trends in human-wildlife conflicts and attitudes towards problematic animal species. Kendall's tau correlation tests are best suited for ordered categorical data (Kendall 1945). A P-value < 0.05 was deemed significant. Data on human-wildlife conflicts were analysed using two methods. First, the total number of reported incidences of human-wildlife conflicts for each year between 2000 and 2010 was regressed against the year to determine the trends in human-wildlife conflicts, i.e., increase, decrease or remained the same. Second, data on the wild animals involved in the human-wildlife conflicts were compared across the

four study communities. Moreover, data on revenue received from CAMPFIRE projects by the four communities were analysed to show the patterns between 2000 and 2010. All analyses were conducted using the Statistical Package for Social Sciences (SPSS version 19, Chicago, USA).

Results

Perceived effectiveness of CAMPFIRE programs

Mahenye had fairly high ratings (CAMPFIRE positive) for all indicators of CAMPFIRE effectiveness, followed by Chibwedziva and Mtandahwe, which could be labelled 'CAMPFIRE neutral'. In contrast, Chizvirizvi had the lowest ratings for indicators of CAMPFIRE effectiveness (CAMPFIRE negative) (Table 3). Ratings for involvement of local people in decision-making related to CAMPFIRE programs, CAMPFIRE-related infrastructural development, anti-poaching by CAMPFIRE resource monitors, conservation awareness and education, employment opportunities related to CAMPFIRE, and cash dividends received under CAMPFIRE significantly differed across the four communities (Table 3). Discussants from the four local communities indicated that cash dividends had declined by 75% to 85% since 2000, which was attributed to high inflation in Zimbabwe. In contrast, only ratings on response to conflicts by responsible authorities, for example, shooting of problem animals, did not differ significantly across the four communities (Table 3), which indicated that there was a need to improve the response mechanisms for dealing with incidences of human-wildlife conflicts.

Table 3. Indicators of success or performance of CAMPFIRE programs in four study communities adjacent to the northern Gonarezhou National Park, Zimbabwe, 2000–2010 (except for Chizvirizvi which started in 2004 after being granted appropriate authority in 2003). Values are the mode and range in parenthesis. *Notes*: Rating scale; 1 = strongly unfavourable, 2 = unfavourable; 3 = neutral; 4 = favourable; 5 = strongly favourable; *N*–sample size; df–degrees of freedom. Values with different superscript letters within rows differ significantly (Kruskal-Wallis test specific comparisons; $P < 0.05$).

Indicator variable	Community				*N*	df	Kruskal-Wallis χ^2	*P*-value
	Chibwedziva	Chizvirizvi	Mtandahwe	Mahenye				
Involvement of local people in decision making under CAMPFIRE	3 (2)^a	2 (3)^a	4 (2)^b	5 (2)^c	60	3	28.92	< 0.0001
Infrastructure (CAMPFIRE related)	3 (2)^a	2 (1)^b	3 (2)^a	5 (1)^c	60	3	39.59	< 0.0001
Anti-poaching patrols by resource monitors	4 (2)^a	1 (1)^b	3 (2)^c	4 (1)^a	60	3	42.19	< 0.0001
Conservation awareness and education	4 (2)^a	2 (2)^b	3 (2)^a	5 (2)^c	60	3	36.62	< 0.0001
Employment opportunities	3 (2)^a	1 (1)^b	3 (3)^a	4 (1)^c	60	3	38.75	< 0.0001
Cash dividends	3 (2)^a	2 (2)^a	2 (2)^a	4 (2)^b	60	3	29.86	< 0.0001
Response to conflicts by responsible authorities (e.g., shooting of problem animals)	2 (2)^a	2 (2)^a	2 (2)^a	2 (2)^a	60	3	3.39	0.642
Overall	3 (2)	2 (1)	3 (2)	4 (3)	–	–	–	–

Experienced conflicts and perceived trends in human-wildlife conflicts

About 85% of the respondents reported that they had experienced conflicts with wildlife, whereas 15% reported that they had not experienced conflicts with wildlife between 2000 and 2010. Proportion of respondents who had experienced conflicts with wildlife was significantly different across the four communities (Table 4). Approximately 72% of the respondents perceived that conflicts with wildlife had increased, whereas 17% and 11% of the respondents perceived that conflicts with wildlife had decreased and remained the same, respectively, between 2000 and 2010. Proportion of responses on perceptions of human-wildlife conflict trends between 2000 and 2010 significantly differed across the four communities (Table 4).

The overall increase in human-wildlife conflicts was largely associated with increases in crop-damage and livestock depredation by large carnivores across the four communities. This was mentioned by many respondents across the communities, as follows: Chibwedziva (n = 56, 93%), Chizvirizvi (n = 47, 77%), Mtandahwe (n = 36, 65%) and Mahenye (n = 41, 68%) communities (χ^2 = 4.97, df = 3, P = 0.174). Only a small proportion of respondents from Mtandahwe (n = 5, 9%) and Chizvirizvi (n = 3, 5%) indicated that increased protection of wildlife had led to an increase in wildlife numbers, hence, the increase in human-wildlife conflicts in adjacent areas. However, the perceived decline in human-wildlife conflicts that was indicated by some respondents from Mahenye (n = 6, 10%) was attributed to shooting of problem animals. Respondents from Mtandahwe (n = 6, 11%) attributed the perceived decline in human-wildlife conflicts to illegal killing of animals in the community.

Table 4. Differences and similarities in opinions regarding human-wildlife conflicts in communities adjacent to the northern Gonarezhou National Park, Zimbabwe. Values are number of respondents and percentages in parenthesis; *N*–sample size; df–degrees of freedom. *Notes*: Values with different superscript letters within rows differ significantly (*z* tests, $P < 0.05$).

Attribute	Responses	Community				*N*	df	Chi-Square (χ^2)	*P*-value	Overall
		Chibwedziva	Chizvirizvi	Mtandahwe	Mahenye					
Experienced conflict with wildlife, 2000– 2010	Yes	60 (100)[a]	47 (77)[b]	42 (74)[b]	51 (85)[b]	236	3	16.59	< 0.001	200 (85)
	No	0 (0)[a]	14 (23)[b]	13 (24)[b]	9 (15)[b]					36 (15)
Perceived trend of human-wildlife conflicts, 2000–2010	Increased	58 (97)[a]	44 (72)[b]	32 (58)[b]	36 (60)[b]	236	6	29.87	< 0.0001	170 (72)
	Decreased	0 (0)[a]	9 (15)[b]	15 (27)[b]	17 (28)[b]					41 (17)
	No change	2 (3)[a]	8 (13)[b]	8 (15)[b]	7 (12)[b]					25 (11)
Measures taken	Report	33 (55)[a]	40 (66)[a]	39 (71)[a]	35 (58)[a]	236	6	11.85	0.065	147 (62)
	No action	22 (37)[a]	15 (24)[a]	6 (11)[a]	17 (28)[a]					60 (26)
	Personal response	5 (8)[a]	6 (10)[a]	10 (18)[a]	8 (14)[a]					29 (12)

Approximately 62% of the respondents indicated that they reported incidences of human-wildlife conflicts to responsible authorities, whereas 26% and 12% of the respondents reported that they took no action since they did not know what to do in cases of human-wildlife conflicts. The remaining 12% of the respondents reported that they took some personal actions, such as scaring away animals or poisoning or illegally hunting the animals when there were incidences of human-wildlife conflicts due to no responses or delayed action from the responsible authorities. The proportion of responses on actions taken in cases on human-wildlife conflicts was similar across the four communities (Table 4).

Relationship between indicators of CAMPFIRE effectiveness and perceived trends in human-wildlife conflicts

We found a trend of lower perceived increase in human-wildlife conflicts with higher and favourable rating of involvement of local people in decision making related to CAMPFIRE programs (Kendall's tau-b = –0.33, $P = 0.048$). In contrast, there were no significant correlations between trends of human-wildlife conflicts and ratings for (i) conservation awareness and education, (ii) anti-poaching activities, (iii) cash dividends, (iv) employment opportunities, (v) CAMPFIRE-related infrastructure, and (vi) response to human-wildlife conflicts by responsible authorities (all, Kendall's tau-b, $P > 0.05$). So, it appears that perceived declines in human-wildlife conflict only partly go hand-in-hand with a higher perceived effectiveness of the CAMPFIRE program.

Attitudes towards common problematic wild animal species

The proportion of responses on lion and hippopotamus being disliked did not differ significantly across the four communities. In contrast, the proportion of responses for those who disliked spotted hyena, leopard, and elephant varied across the four communities (Table

5). The respondents from all four communities gave three reasons why they disliked the five problematic animals, namely livestock depredation by large carnivores (n = 150, 64%), crop damage mostly by elephants and hippopotamus (n = 134, 57%), and the five animal species were also seen as dangerous to human life (n = 95, 40%). Reasons why respondents disliked the problematic animals did not differ significantly across the study communities. Compared to other communities, Chibwedziva had the highest dislike of problematic wild animals, whereas Mtandahwe had the least dislike of problematic wild animals. The dislike of lion was negatively correlated with high rating of conservation awareness and education (Kendall's tau-b = –0.91, P = 0.035). In contrast, elephant, hippopotamus, leopard, and spotted hyena were not significantly correlated to any of the measured ratings of CAMPFIRE effectiveness.

Table 5. Differences and similarities among the four communities on the disliked animal species. Values are number of respondents and percentages in parenthesis; *N*–sample size; df–degrees of freedom. *Notes*: Total percentage exceeds 100 for each community because the respondents were allowed to give multiple answers. Values with different superscript letters within rows differ significantly (*z* tests, $P < 0.05$).

Common name	Community				*N*	df	Chi-Square (χ^2)	*P*-value	Overall
	Chibwedziva	Chizvirizvi	Mtandahwe	Mahenye					
Lion	37 (62)[a]	48 (79)[a]	42 (76)[a]	37 (62)[a]	236	3	7.12	0.068	164 (70)
Spotted hyena	49 (82)[a]	43 (70)[a]	32 (58)[b]	34 (57)[b]	236	3	11.00	0.012	158 (67)
Elephant	45 (74)[a]	27 (45)[b]	15 (27)[c]	37 (62)[a]	236	3	28.48	<0.0001	124 (52)
Leopard	36 (60)[a]	29 (48)[a]	14 (25)[b]	16 (27)[b]	236	3	20.69	<0.0001	95 (40)
Hippopotamus	14 (22)[a]	11 (18)[a]	7 (13)[a]	8 (13)[a]	236	3	1.89	0.595	40 (17)

Trends in human-wildlife conflicts and CAMPFIRE revenues

Trends in the recorded human-wildlife conflicts incidences in the study communities between 2000 and 2010 are shown in Fig. 2. Overall, there was a non-significant increase in reported incidences of human-wildlife conflicts in Chibwedziva (t = 1.26, β (slope) = 0.39, 95% Confidence Limits (CL) of slope = –0.17 to 0.61, P = 0.240), Mtandahwe (t = 0.90, β = 0.29, 95% CL of slope = –0.31 to 0.71, P = 0.393), and Mahenye (t = 1.26, β = 0.43, 95% CL of slope = –0.12 to 0.40, P = 0.249). Further, a total of 10 animal species was recorded to have been involved in human-wildlife conflicts in the four communities (Table 6). Mahenye had the highest number of problem animal species, followed by Chibwedziva and Mtandahwe, whereas Chizvirizvi had the least number of recorded problem animal species. Five additional species, namely baboon, buffalo, bushpig, crocodile, and warthog, were recorded as having been also involved in human-wildlife conflicts, mostly in Mahenye, Chibwedziva, and Mtandahwe communities.

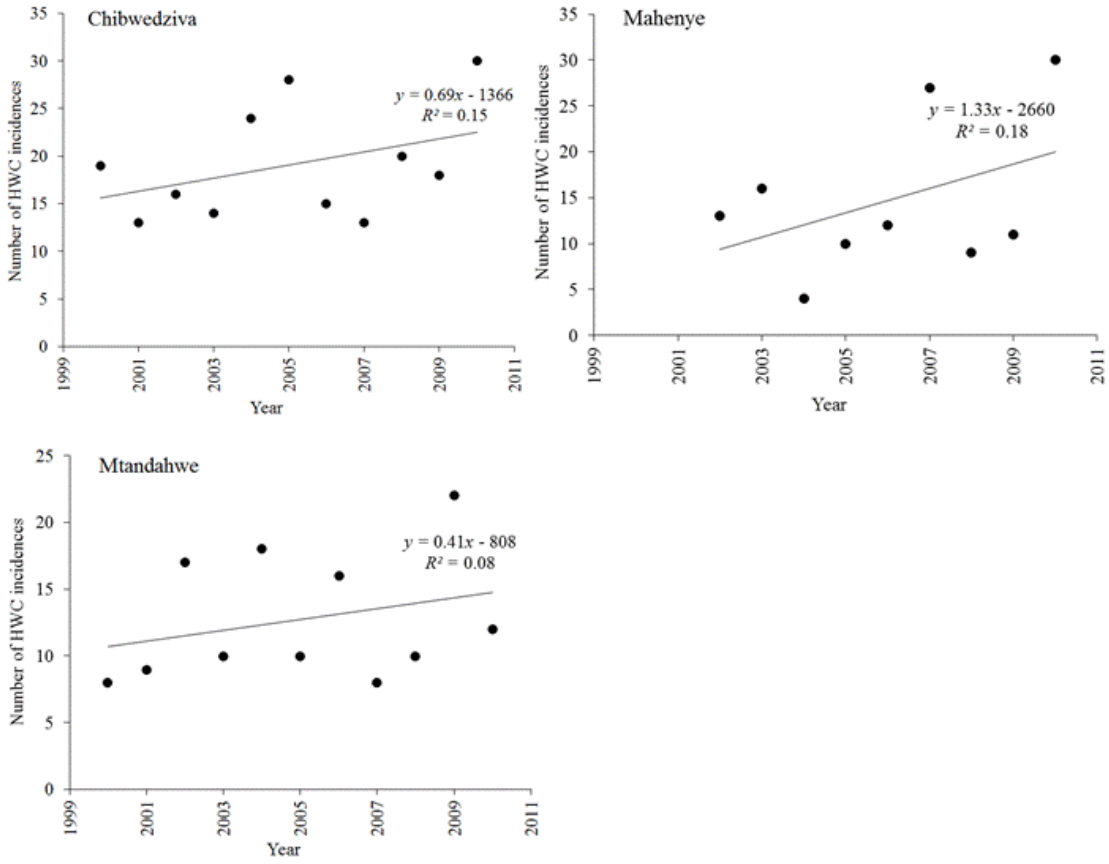

Fig. 2. Trends in recorded human-wildlife conflict (HWC) incidences in communities adjacent to the northern Gonarezhou National Park, Zimbabwe, between 2000 and 2010. *Note*: Human-wildlife conflict incidences data for Chizvirizvi were unavailable.

Table 6. Animal species which were recorded as being involved in human-wildlife conflicts in the four study communities adjacent to the northern Gonarezhou National Park, Zimbabwe, between 2000 and 2010. *Notes*: X = recorded to have been involved in conflict with local communities.

Common name	Scientific name	Chibwedziva	Chizvirizvi	Mtandahwe	Mahenye
Baboon	*Papio ursinus*			X	X
Buffalo	*Syncerus caffer*	X			X
Bushpig	*Potamochoerus larvatus*				X
Crocodile	*Crocodylus niloticus*	X		X	X
Elephant	*Loxodonta africana*	X	X	X	X
Hippopotamus	*Hippopotamus amphibius*	X		X	X
Leopard	*Panthera pardus*	X	X	X	X
Lion	*Panthera leo*	X	X	X	X
Spotted hyena	*Crocuta crocuta*	X	X	X	X
Warthog	*Phacochoerus africanus*				X

Moreover, there were variations in revenue received by the four study communities under CAMPFIRE between 2000 and 2010 (Table 7). Chibwedziva recorded an increase in revenue between 2000 and 2001, but revenue declined in 2002, 2003, 2005, 2007, and 2008. A peak of more than US$109,000 was recorded in 2001, whereas the lowest figure of US$2 was recorded in 2008 by Chibwedziva. Chizvirizvi recorded low revenues in 2004 and 2005, but a peak of US$16,225 was recorded in 2009. Mtandahwe recorded an increase in revenue between 2000 and 2002, which was followed by a decline in revenue between 2003 and 2005. In contrast, revenue received for Mtandahwe increased between 2006 and 2010, and peaked at US$16,000 in 2010. Mahenye had a peak of more than US$109,000 in 2002, which was followed by a huge decline in revenue between 2004 and 2007. However, revenue received in Mahenye increased in 2009 and 2010.

Table 7. Revenue received by Chibwedziva, Chizvirizvi, Mahenye and Mtandahwe CAMPFIRE communities from the Rural District Councils and safari operator between 2000 and 2010. *Source*: Chiredzi Rural District Council, Mahenye and Mtandahwe CAMPFIRE committees and Lowveld Hunters databases. *Notes*: Z$ denotes Zimbabwean dollar; US$ denotes United States dollar; n/a denotes not applicable; – denotes unavailable. Revenue (US$) are based on the official exchange rates from Wikipedia (http://en.wikipedia.org/wiki/Zimbabwean_dollar). The Zimbabwean dollar was officially abandoned as an official currency in 2009.

Year	Chibwedziva		Chizvirizvi		Mtandahwe		Mahenye	
	Z$	US$	Z$	US$	Z$	US$	Z$	US$
2000	1,274,308	23,169	n/a	n/a	180,000	3,273	–	–
2001	6,004,392	109,171	n/a	n/a	230,000	4,182	–	–
2002	689,587	12,538	n/a	n/a	270,000	4,909	5,995,918	109,017
2003	7,600,720	1,326	n/a	n/a	350,000	61	20,770,766	3,625
2004	59,568,000	10,396	5,000,000	873	375,000	65	126,397,780	22,059
2005	78,004,500	922	64,900,000	767	460,000	5	199,874,814	2,363
2006	1,724,506,500	17,041	870,000,000	8,597	95,000,000	939	769,260,502	7,602
2007	9,781,200	31	–	–	650,000,000	2,055	1,221,094,925	3,861
2008	156,205,117	2	–	–	850,000,000,000	8,500	–	–
2009	–	28,405	–	16,225	–	8,000	–	68,127
2010	–	24,650	–	7,000	–	16,000	–	37,797

Discussion

Living in close proximity to protected areas imposes costs such as damage or loss of crops and livestock, and occasionally injury or death of local people (Deodatus 2000; Woodroffe et al. 2005). These costs increase as conservation efforts lead to recovery of animal populations, and as human population growth leads to an increase in the proportion of land outside the parks that is used for agriculture (Richardson et al. 2012). Our results show that human-wildlife conflicts were perceived to be prevalent in the study area between 2000 and 2010. Conflicts with wildlife over crops, livestock, and human safety issues were reported in all four local communities, irrespective of the perceived level of CAMPFIRE effectiveness. In concert with scientific studies conducted in Gonarezhou (Dunham et al. 2010; Gandiwa 2012; Gandiwa et al. 2013b), local residents asserted that some populations of large herbivores and carnivores, particularly elephants, spotted hyena, and lions, had increased. These assertions were based largely on recorded increases in crop damage and livestock depredation by large carnivores between 2000 and 2010. However, we recorded a non-significant increase in the number of human-wildlife conflict incidences in the study communities. This non-significant trend could be a result of some local people not reporting incidences of conflict with wildlife.

Our results show that most indicators for CAMPFIRE effectiveness were not associated with a decline in experienced human-wildlife conflicts. However, involvement of local people in decision-making was indeed positively correlated with a lower perceived increase in human-wildlife conflict, even though a higher proportion of residents had experienced problems with animals. Elsewhere, in Masoka, northern Zimbabwe (Matzke & Nabane 1996) and Tsholotsho district near Hwange National Park, western Zimbabwe (Vorlaufer 2002), fences had to be erected between wildlife areas and villages as a way of minimising human-wildlife conflicts. Human-wildlife conflicts have been reported to be

prevalent in several community-based natural resources management programs, for example, in Botswana (Mbaiwa 2005) and Zambia (Richardson et al. 2012).

Our study findings show that there are differences and similarities in effectiveness of CAMPFIRE programs across the four study communities. Contextual factors across the four communities seem to influence the perceived effectiveness of CAMPFIRE programs. Further investigation revealed that Mahenye, which had the highest ratings for indicators of CAMPFIRE effectiveness despite the decline in Zimbabwe's economy since 2000, was among the first communities in Zimbabwe to implement community-based natural resources management projects before the official launch of the CAMPFIRE program in 1989. Conservation projects in Mahenye started in 1982, and this resulted in the community developing several income-generating projects, including a high-end tourism lodge, which created more employment opportunities, a well-structured anti-poaching team, and awareness and education programmes (Chigwenya & Chifamba 2010).

Moreover, the success of Mahenye community in CAMPFIRE has been attributed to the commitment of socially dedicated individuals in positions of influence or leadership, the balancing sources of traditional and popular legitimacy, the presence of an enlightened private sector, the existence of a rich natural resource base, the capacity for flexibility and acceptance of innovation and risk, the existence of intra-communal cohesiveness, and the presence of economic incentives in the form of regular annual distribution of household dividends in an equitable and transparent manner (Murphree 2001). However, it has been reported that since 2000, the Mahenye community has experienced challenges with CAMPFIRE because local people have been receiving few benefits and there has been less involvement of local people in decision-making processes related to CAMPFIRE. These challenges have been reportedly related to changes in chieftainship, involvement of the new chief in determining the composition of the CAMPFIRE committee in 2001, election of a new ward councillor, and

lack of transparency in tendering the hunting concession (Rihoy & Mugaranyanga 2007). Despite these challenges, the people of Mahenye have reportedly continued to demonstrate a remarkable level of intra-communal cohesiveness (Murphree 2001).

Only Mahenye, Chibwedziva, and to some extent Mtandahwe recorded an increase in natural resources monitoring and law enforcement due to the availability of financial resources from the accrued CAMPFIRE benefits. In contrast, monitoring and law enforcement of natural resources was nonexistent in Chizvirizvi. Further, the involvement of local people in decision making in the CAMPFIRE program was very low in Chizvirizvi. The failure of the CAMPFIRE program in Chizvirizvi has been attributed to the coercive and often violent activities of war veterans within the community, which have eroded the power and influence of both the developmental resettlement committee and traditional leadership; the lack of democratic elections for CAMPFIRE committee; the lack of involvement of local people in management activities or decisions regarding wildlife management; and the lack of benefits to local households from wildlife management (Rihoy & Mugaranyanga 2007).

Differences in CAMPFIRE effectiveness and human-wildlife conflicts reported in this study could also have been influenced by several other factors. For instance, Chizvirizvi had the shortest length of community-based wildlife management because appropriate authority was granted only in 2003, whereas in the other three communities, CAMPFIRE has been running since the early 1990s. This difference in length of involvement with CAMPFIRE among the study communities may have influenced the cohesiveness and involvement of local people in the community, since Chizvirizvi is a resettlement area. In addition, of the four communities, only Mahenye had tourism infrastructure (lodges); hence, the community had diversified forms of revenue generation, which increased the community benefits, even during the period of economic decline in Zimbabwe between 2000 and 2008. Chibwedziva is adjacent to an area of Gonarezhou that has a slightly higher density of wild animals, e.g.,

elephant, compared to the other three communities, which corresponds to the perceived high conflicts. Moreover, differences in human population densities across the four communities could also have influenced variations in benefits accrued by local people, as shown by perceptions of effectiveness of CAMPFIRE indicators recorded in this study. Chibwedziva had the highest density (32 people km^{-2}), followed by Mtandahwe (23 people km^{-2}), Mahenye (18 people km^{-2}), and Chizvirizvi (12 people km^{-2}). Besides Chizvirizvi, where CAMPFIRE was not functioning well, Mahenye with a relatively low human density, had higher ratings for benefits and other indicators of CAMPFIRE effectiveness accrued compared to Mtandahwe and Chibwedziva. Perceptions of human-wildlife conflict trends could also have been influenced by distance of the village from the park boundary and other adjacent wildlife areas. Local people living close to protected areas are likely to experience more conflict than those further away (Mackenzie 2012b). For instance, Chizvirizvi borders Gonarezhou and a fenced boundary with Malilangwe. Only Mahenye had both villages close to Gonarezhou boundary, whereas the other three communities had one village close to the park boundary and the other further away.

Our results show that across the four study communities there was a widespread dislike of and negative attitudes towards most of the common problematic wild animals, although only a lower dislike of lion was associated with communities with a higher rating for conservation awareness and education. Chibwedziva had the overall highest dislike of the problematic wild animals, probably due to the area's proximity to Gonarezhou, which resulted in these species frequently moving into the community. Mtandahwe had the lowest dislike of problematic wild animals because most of residents wanted to have more animals on a sport hunting quota that is specific to the area. Mtandahwe and Mahenye have a single quota, but most animals are hunted in Mahenye and most profits go to Mahenye.

Livestock depredation by large carnivores and crop raiding by mostly elephant were the main reasons why the animals were disliked. Human-wildlife conflicts in Zimbabwe are compounded by the fact that proceeds from the killing of problem animals, such as elephant, in terms of meat, and/or safari hunting are given to the entire CAMFIRE community and not specifically the individual household affected (Madzudzo 1997). This procedure unfortunately neglects those particular groups who bear the costs of living close to wildlife. It has been suggested that residents who feel they are benefiting from wildlife have more positive attitudes towards wildlife species compared to those without any benefits (Kideghesho et al. 2007).

Quite striking was the overall dissatisfaction in the four local communities with the response to human-wildlife conflicts, for example, shooting of problem animals, by the responsible authorities. Local resource management capacity in terms of responses to incidences of human-wildlife conflicts could have been negatively affected by resource constraints due to the economic decline in Zimbabwe between 2000 and 2008. Financial difficulties led to challenges in purchasing ammunition for controlling problem animals and obtaining resources for responding to problem animals, and resulted in RDCs reducing the proportion of revenue they gave back to the CAMPFIRE communities (Mapedza 2009).

The economic collapse in Zimbabwe, high inflation, and the withdrawal of the donor community following the land reforms since 2000 have been reported to have eroded the benefits that most conservation programs derive from the communal areas, given that payments of household cash dividends from CAMPFIRE revenue activities take place six months to a year after activities have occurred (Mapedza & Bond 2006; Rihoy & Mugaranyanga 2007; Fischer et al. 2011). For instance, in 1999, each household in the Mahenye community received an average earning of US$59 (Vorlaufer 2002). However, in 2008, discussants from Mahenye revealed that they received an average earning of $10. With

the exception of Chizvirizvi, our results similarly show that revenue received under CAMPFIRE markedly declined in Chibwedziva, Mahenye, and Mtandahwe between 2003 and 2008, likely due to the high inflationary environment in Zimbabwe following the political unrest and economic decline since the land reforms in 2000. A key constraint to the success of community-based natural resource management in many countries is the high tax on wildlife, as reflected in the retention by central and local governments of a high proportion of the revenues generated by wildlife-based tourism. In Namibian communal lands, the establishment of community conservancies where the full benefits of wildlife-based tourism are retained at locals levels has led to a dramatic increase in both wildlife populations and revenues to communities in the past 20 years (Weaver et al. 2011). However, in the case of Chizvirizvi, where the money does not pass through the local government, there were indications that the money was not being directly channelled to the community.

Conclusion

Human-wildlife conflicts in the study area have implications for local livelihoods since communities in the southeast lowveld of Zimbabwe and those in the Great Limpopo Transfrontier Conservation Area rely mainly on crop production and livestock rearing (Cumming 2005). Moreover, the removal of fences in some wildlife areas under the transboundary management of resources through the Great Limpopo Transfrontier Conservation Area and issues of wildlife health, domestic animal health, and human health and livelihoods (Osofsky et al. 2005) should take into cognisance the current levels and future dynamics of human-wildlife conflicts.

Our findings partly support our first hypothesis that a higher perceived effectiveness of CAMPFIRE would be associated with a decline in human-wildlife conflicts, even though many people had experienced problems with wild animals. Of the various indicators of

CAMPFIRE effectiveness, only involvement of local people in decision-making correlated with a lower perceived increase in human-wildlife conflicts. This suggests that having influence in, and ownership of, wildlife management programs may be more important in influencing perceived conflicts with wildlife than is direct economic benefit. We also recorded mixed attitudes towards problematic wild animals, with little association with perceived CAMPFIRE effectiveness. Only for one of the problem animals (lion) was there a relation with one dimension of CAMPFIRE effectiveness (conservation awareness and education). Our results, therefore, only minimally support our second hypothesis that local communities with high perceived effectiveness of CAMPFIRE programs would have more favourable attitudes towards problematic wild animals. The perceived effectiveness of CAMPFIRE programs and attitudes towards problematic animal species varied among local communities primarily due to contextual differences.

Despite the recorded differences in perceived CAMPFIRE effectiveness and human-wildlife conflicts among the four study communities, our results show that even if it is difficult to provide material benefits, it still seems beneficial to involve the local people in decision-making (Weaver et al. 2011) in CAMPFIRE programs. Similarly, it has been suggested that CAMPFIRE's most important principle is involving the rural population in decisions about the implementation of CAMPFIRE and the use of the revenue gained (Vorlaufer 2002). Our study provides an important lesson for ICDPs, since the situation in Zimbabwe is not unique. On the basis of data from this study, we recommend the following: (i) decisions and actions regarding the control of problem animals need to be devolved to the community level, and (ii) conservation awareness and education need to be enhanced to improve attitudes towards problematic animal species and to minimise the negative impacts of human-wildlife conflicts in community-based natural resource management initiatives.

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CHAPTER 5: Spill-over effect in media framing: Representations of wildlife conservation in Zimbabwean and international media, 1989–2010*

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* *This Chapter is submitted as:*

Gandiwa, E., Sprangers, S., van Bommel, S., Heitkönig, I.M.A., Leeuwis, C. and Prins, H.H.T. Spill-over effect in media framing: Representations of wildlife conservation in Zimbabwean and international media, 1989–2010.

Abstract

Myths and metaphors that occur in media frames play an important role in influencing public perceptions in times of war, political conflict, crisis and disaster. This, in turn, influences policy makers and (inter)national assistance and aid programs. We investigated whether a metaphoric spill-over of frames used in connection with political events could explain the misrepresentation in the framing of non-political issues such as wildlife conservation. Zimbabwe experienced a severe political conflict and economic downturn in 2000 when violent land reforms took place. We analysed newspaper articles on Zimbabwe's wildlife conservation published between 1989 and 2010 from newspapers in Zimbabwe, the United Kingdom and the United States of America. We selected three issues about wildlife conservation in Zimbabwe in the local and international media, namely, the ivory ban, rhino protection, and Communal Areas Management Programme for Indigenous Resources to investigate the spill-over effect. Our results show that in the 1990s, the majority of newspaper articles highlighted that wildlife conservation in Zimbabwe was largely successful. However, two major changes occurred after 2000 following the land reforms in Zimbabwe. First, the international media lost interest in wildlife conservation in Zimbabwe as evidenced by a sharp decline in published articles and second, the frames changed in the international media with the "political unrest and land reform" blame frame becoming more dominant. This transition in reporting, frames, and low frame parity shows that there was a spill-over effect of political frames into wildlife conservation following Zimbabwe's land reforms in 2000. Metaphoric spill-over effects may thus create myths in the readership, in turn influencing policy-derived actions in a sector that is not or poorly related to the actual disaster.

Keywords: Framing; land reform; metaphors; nature conservation

Introduction

Zimbabwe has been a subject of political crisis and economic collapse since the end of the 1990s (Coltart 2008). The country seems nowadays to be mainly known for its extreme land reforms, economic malaise and contested elections. These themes have been the main focus of articles appearing in the different media over the last years (Ndlela 2005; Shaw 2008). The American Ambassador even declared Zimbabwe a disaster area on several occasions after the year 2000 following the country's land reforms (United States Agency for International Development 2012). Wildlife conservation in Zimbabwe has also been widely reported in the mass media as having suffered from the unstable political situation and economic collapse in the country (Shaw 2008). However, recent scientific studies provide evidence that at least in some state protected areas in Zimbabwe wildlife populations have remained stable or have increased over the past two decades (Valeix et al. 2008; Dunham et al. 2010; Zisadza et al. 2010; Gandiwa et al. 2013a; Gandiwa et al. 2013b). This suggests that framing of wildlife conservation in Zimbabwe in the international media does not reflect reality.

Media studies on the role of media in times of political conflict and crisis (Entman 2003; Tierney et al. 2006; Kolmer & Semetko 2009; Alozie 2010) and natural disaster (Sonnett et al. 2006; Tierney et al. 2006; Fu et al. 2012) show that the media often use metaphors that unintentionally misrepresent the situation in ways that confirm prevailing myths – such as looting, social disorganisation and deviant behaviour during disaster – despite accumulating counter evidence which shows that in reality social cohesiveness and informal mechanisms of social control actually increase during disasters, resulting in a lower incidence of deviant behavior than during non-disaster times. This misrepresentation in the media is worrisome because the media are one of the principal arenas within which issues come to the attention of decision makers, interest groups and the public (Barua 2010). The way media choose to frame an issue influences how the readership - including policy makers (Boykoff &

Roberts 2007) and national and international donors (Garner 1996; Entman 2004; Kolmer & Semetko 2009) - perceives certain issues and subsequently acts upon it (Callaghan & Schnell 2005; Sun 2011). For nature conservation this could imply that misrepresentation in the international media could lead to reduced international aid and support.

In this paper, we investigate if the framing of political events such as land reform in Zimbabwe, in national and international media could give us insight into the misrepresentation in the framing of non-political issues such as wildlife conservation. Identifying such a possible 'spill-over effect' is valuable in understanding the dynamics of media framing and the consequences of this, particularly in areas that have experienced unrest or other crises in society. We analyse how issues on wildlife conservation are framed, which frames are dominating the discourse, how these frames changed over time, how these frames related to the framing of the political events in the country, and whether these frames reflected the actual state of wildlife conservation at the time.

Theoretical framework

Myths refer to the often negative, fixed ideas people often seem to have about what happens in a disaster area (Tierney et al. 2006; Stock 2007; Kuttschreuter et al. 2011); they can have a great influence on how certain situations are responded to. For example, news coverage after Hurricane Katrina hit New Orleans in the United States of America (USA) in 2005, was generally sympathetic to victims, but also included instances of violence, looting and crime (Iyengar & Hahn 2007). The "looting" frame greatly exaggerated the incidence and severity of looting and lawlessness, despite evidence to the contrary, and thus was a myth. Yet, it was accepted as the truth by many influential decision makers. It emerged as the problem frame in the aftermath of Hurricane Katrina (Tierney et al. 2006), and resulted in the USA Government

starting to treat the crisis in a completely different manner, shifting the focus on creating order rather than giving aid (Tierney et al. 2006).

Framing, a term first coined by Goffman (1974), is an important process through which myths may emerge. Entman (1993, p. 52) defined framing as*:* "to select some aspect of a perceived reality and make it more salient in a communicating text in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described." Framing, therefore, refers to how the media, media professionals and their audience make sense of events or issues (Reese 2007). Thus, framing plays an important role in media representation (Tuchman 1978; Entman 1993; Hallahan 1999) since it defines the boundaries of the debate by placing the event or issue within a certain sphere of meaning (Kruse 2001; De Boer et al. 2010; Gasper et al. 2013).

It has been noted that media frames used in one realm (e.g., politics) can influence and spill-over to other societal domains (Graber & Smith 2005; Vliegenthart & Walgrave 2011). In such cases frames used in one domain are used as a metaphor (i.e., a figure of speech that suggests resemblance between essentially unrelated phenomena) for what happens in another domain (Lakoff & Johnson 1981; Lakoff 1993). Metaphors are regularly used by journalists for the purposes of: i) popularizing, representing and dramatizing issues in order to make issues both newsworthy and interesting for the relevant audiences and ii) helping people understand unfamiliar and complex issues by making them familiar through shared experiences, and by narrowing the perspective of complex issues (Hellsten 2002; Tierney et al. 2006). When metaphoric spill-over of frames happens in the context of amplification in the media following disasters or crises in one realm (Ndlela 2005; Kuttschreuter et al. 2011; Eckler & Kalyango 2012) it is clear that this may contribute to the creation of myths regarding the other domain.

The present study focusses on understanding if the (mis-)representation of wildlife conservation in Zimbabwe in the international media could be explained by a possible spill-over effect through getting insights into whether the framing of political issues had influenced the framing in the conservation realm. To get insight into the framing of nature conservation in the national and international media and its underlying assumptions, we will draw on the four functions of frames as defined by Entman (1993) namely (i) defining the problem, (ii) diagnosing the causes, (iii) making moral judgment evaluating the cause and its effects, and (iv) offering remedies and justifies treatments for it. In addition to that, we will also investigate the biases in the media representation of nature conservation by looking into the extent of 'frame parity' in the newspaper articles. Frame parity refers to the desired objectivity of the media through highlighting all sides of a story, a condition that most free press prefers (Entman 2004). Last but not least, we will investigate if there are certain discourse coalitions within the national and international media by investigating the ensemble of story lines, the actors that utter these story lines, and the practices that conform to these story lines.

Historical context

Zimbabwe is a landlocked country located in southern Africa. Colonisation started when the British South Africa Company entered the country exploring for minerals in 1889 (Lucas et al. 2011). In 1923 Britain annexed what at that time was called Southern Rhodesia from the British South Africa Company (Lucas et al. 2011). In 1965, the Ian Smith government declared independence, which was neither not recognized by the British Government nor by the black majority (Onslow 2005). After a liberation struggle, the Lancaster House agreement was signed in 1979, which gave Zimbabwe independence from Britain (Slinn 1980). After the 1980 elections, Robert G. Mugabe became the first Prime Minister as Zimbabwe achieved an

internationally recognized independence in 1980. Land has been a major issue in Zimbabwe before and after independence in 1980 (Moyo et al. 2000). Historically, there has been bitter competition for land and resources between black and white farmers in Southern Rhodesia, with the state providing extensive and crucial support to white agriculture (Palmer 1990). A major concern for the Zimbabwe Government after independence was to carry through land reform in the rural areas (Palmer 1990).

After independence, 31 nations and 26 international agencies pledged about $1.5 billion in economic aid to Zimbabwe that was to be disbursed over a three-year period as of 1981 (Dougherty 1981). Of the amount contributed 94% came from western countries. The USA pledged $225 million over a three-year period (Chigora 2007). By the end of 1986 the USA had contributed $380 million. However, in July 1986, the US Government decided to discontinue future bilateral aid to Zimbabwe as a result of a continuing pattern of uncivil and undiplomatic statements and actions by the government of Zimbabwe in the United Nations and elsewhere (Chigora 2007). Full programming was restored in 1988. The Lancaster House agreement made clear that the British/United Kingdom (UK) Government would pay the white farmers that would volunteer to sell their land for market price, thus enabling land transformation (Nmoma 2008; Musemwa & Mushunje 2011). However, in 1997 British Prime Minister Tony Blair declared that his government had no intention of honouring former Prime Minister John Major's commitment to finance land redistribution (Nmoma 2008).

In February 2000, mass land occupations on large-scale commercial farms and private-owned wildlife reserves started in Zimbabwe (Willems 2004) following the government loss of the 1999 constitutional referendum, ahead of the 2000 parliamentary and 2002 presidential elections (Ndlela 2005). A law was passed in 2002 allowing the government to pursue the fast track land reform programme (Moyo & Yeros 2005). Fast track refers to the speedily nature in which the land reform process was conducted in the identification of at

least five million hectares of land for compulsory acquisition and resettlement. This was condemned by the British Government and others, and sanctions were imposed on Zimbabwe by the European Union and USA. Loans and economic aid from many donors were limited or completely withdrawn (Chigora 2007; Logan 2007). This resulted in food shortages, high rates of unemployment, high inflation and economic collapse (Ndlela 2005; Hanke & Kwok 2009). Also the 2008 elections were controversial, and led to a power sharing agreement– referred to as the Global Political Agreement (Raftopoulos 2010). In 2009, the US Dollar, Rand and Euro replaced the Zimbabwean dollar ending hyper-inflation (Chingono 2010). The situation in Zimbabwe has been described as a disaster on several occasions over the last decade (Coltart 2008). Other sources have described the situation in Zimbabwe as a humanitarian crisis (Human Rights Watch 2002).

Methods

Research approach

Given the political turmoil in Zimbabwe, this country was considered an interesting case for studying spill-over effects. We approached our case study form a holistic, historical and comparative perspective. A holistic perspective implies an effort to shed light on the connections between and interactions of various phenomena in a greater whole. A historical perspective intends to uncover how events and phenomena in the past affect following events and phenomena. A comparative perspective enables refinement of interpretations produced in a case study, as well as the concepts and frameworks that were used to create interpretations (cf. Blok 1977).

The holistic perspective, lead us to deal with context of how wildlife conservation in Zimbabwe as a whole was generally framed in the media over the study period. Specifically, the holistic perspective allowed us to evaluate the interactions between the following key

components of wildlife conservation in Zimbabwe: i) ivory ban, ii) rhino protection, and iii) wildlife conservation policy (Communal Areas Management Programme for Indigenous Resources - CAMPFIRE). The historical perspective, lead us to follow the framing of wildlife conservation in Zimbabwe over a period of more than 20 years. We focussed on newspaper articles including the subject of wildlife conservation in Zimbabwe, published between 1989 and 2010. The year 1989 was the starting point because this is the year in which the ivory ban was placed by the Convention of International Trade in Endangered Species (CITES) and also the year in which CAMPFIRE was implemented in Zimbabwe. Moreover, rhino protection was also an important component of wildlife conservation in Zimbabwe by 1989. We included articles up to 2010 to cover the period after the fast track land reforms after the passing of the land reform bill by the Parliament of Zimbabwe in 2002. We divided the data in two periods, i.e., 1989–1999 and 2000–2010.

Last but not least, we compared newspapers in different countries in order to see whether there were differences and similarities in framing wildlife conservation in Zimbabwe (in particular on ivory ban, rhino protection and CAMPRIRE) and between these countries in the articles published overtime. Three countries were selected for this perspective. First, Zimbabwe, which was expected to report mostly positively on wildlife conservation practices in the country. Second, the UK because of its colonial history and present-day relationship with Zimbabwe, and third, the USA because of its involvement and support of Zimbabwe's wildlife conservation practices and other close economic and political links. From these three countries, a total of seven newspapers which published articles covering the study period were selected: UK (The Guardian, The Independent and The Times), USA (The Miami Herald, The New York Times and The Washington Times) and Zimbabwe (The Herald). The Herald (Zimbabwe) was chosen as it was the only newspaper in Zimbabwe which published relevant articles on wildlife conservation throughout the study period.

Data collection and analysis

Available data on elephant populations in Zimbabwe between 1989 and 2010 were collated from published sources (Department of National Parks and Wildlife Management 1996; Dunham & Mackie 2002; Government of Zimbabwe 2010). Data on rhino populations and rhino poaching in Zimbabwe and South Africa between 1989 and 2010 were collected from published sources (Lindsey & Taylor 2011; Milliken & Shaw 2012), the World Wildlife Fund Zimbabwe and Zimbabwe Parks and Wildlife Management Authority whereas data on revenue accrued from CAMPFIRE were collected from the CAMPFIRE Association of Zimbabwe. However, data on national elephant populations in Zimbabwe and CAMPFIRE revenue were only available for the period 1989 to 2006. We performed simple linear regression analyses using SPSS version 19 for Windows (SPSS Inc., Chicago, Illinois) to determine trends in elephant population, rhino population and numbers of rhinos poached between 1989 and 2010. Rhino data were $\log_{10}(x + 1)$ transformed prior to regression analyses to achieve normality. Year was the independent variable and elephant and rhino data the dependent variables. For rhino (transformed) and CAMPFIRE revenue data, we performed independent samples two-tailed *t*-tests with unequal sizes to determine if there were differences before and after 2000.

Moreover, data on published articles on wildlife conservation in Zimbabwe were collected using two methods. First, for the UK and USA newspapers, data were gathered using the online LexisNexis® Academic database. Three main key words used for the online search were Zimbabwe AND Wildlife AND Conservation. Second, for The Herald newspaper (Zimbabwe), data were manually gathered through collecting hard copy newspaper clippings which discussed wildlife conservation from the Zimbabwe Parks and Wildlife Management Authority Library in Harare in May 2011. A total of 650 articles were used for this study.

The selected newspaper articles were read and coded by the first two authors, based on the main contents of the article. From this the following three issues emerged as key issues: the ivory ban, rhino protection and wildlife conservation policy (CAMPFIRE). These issues were: i) mostly published in newspapers in all three countries, ii) important in showing innovative ways in animal species protection, and reducing illegal hunting and trade in wildlife products, and iii) important in revenue generation for wildlife conservation and local community development. Then Entman's (1993, 2004) four functions of a frame were used in each article in order to identify the different types of frames that appeared in the articles. The articles were further classified for frame parity. In the case of the rhino protection and CAMPFIRE issues, the articles were labelled as showing frame parity or not. On the ivory ban issue, six categories were chosen: in favour of the ban (no frame parity), opposing the ban (no frame parity), neutral (frame parity), neutral leaning towards opposing the ban (some frame parity), neutral leaning towards in favour of the ban (some frame parity), and neutral but against Zimbabwe (some frame parity). Discourse coalitions were closely examined through careful review of newspaper articles on possible coalitions' actions and positions regarding wildlife conservation.

Results

We first present the trend analysis of elephant population, rhino population, rhino poaching and CAMPFIRE revenue in Zimbabwe between 1989 and 2010; then the quantitative overview of the entire study period for the three study issues, followed by a frame analysis for the each of the two periods (1989–1999 and 2000–2010).

Trends in elephant, rhino populations and CAMPFIRE revenue

The elephant population in Zimbabwe significantly increased between 1989 and 2006 ($F_{1,4}$ = 16.66, P = 0.015; Fig. 1). Moreover, in the late 1980s and early 1990s, a high rate of rhino poaching was recorded in Zimbabwe, mostly from cross-border poachers. Thereafter, poaching was reduced due to the establishment of rhino intensive protection zones and implementation of dehorning programs. Rhino poaching resurfaced in Zimbabwe after 2000. Compared to South Africa, Zimbabwe recorded worse losses between 1989 and 2010, both in absolute and relative terms (Table 1). However, rhino populations (R^2 = 0.04, $F_{1,18}$ = 0.73, P = 0.405) did *not* decline and numbers of poached rhinos (R^2 = 0.01, $F_{1,20}$ = 0.002, P = 0.962) in Zimbabwe did *not* change significantly between 1989 and 2010. Furthermore, the rhino population (t = –2.03, df = 18, P = 0.057) and number of poached rhinos (t = –0.80, df = 20, P = 0.432) in Zimbabwe did *not* differ significantly before and after 2000. In contrast, the rhino population (R^2 = 0.96, $F_{1,20}$ = 540.72, P< 0.0001) and number of poached rhinos (R^2 = 0.50, $F_{1,20}$ = 20.10, P< 0.0001) in South Africa have shown a steady increase between 1989 and 2010.

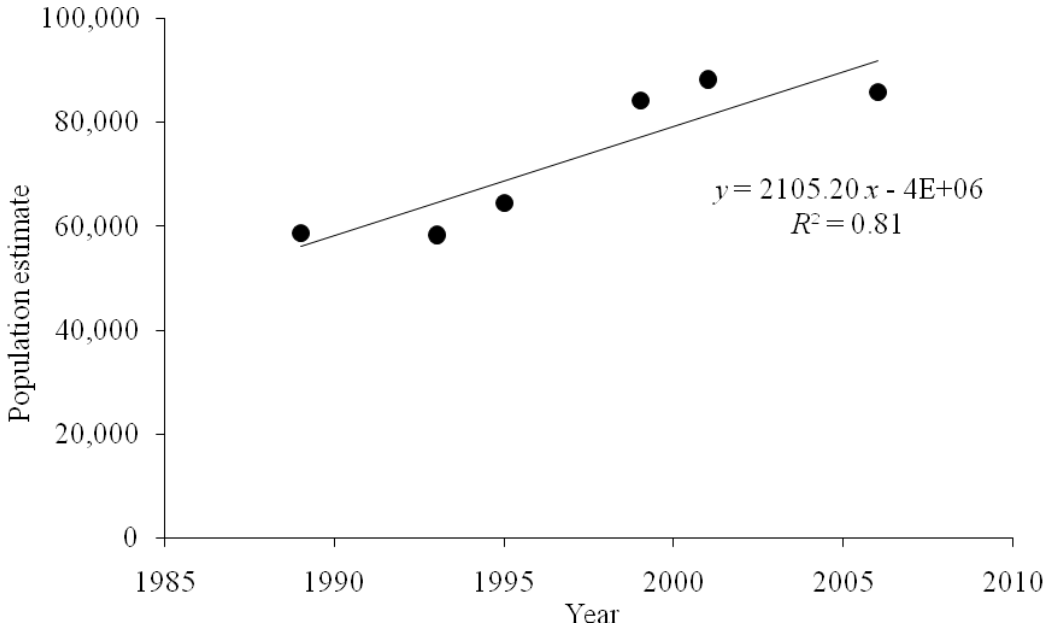

Fig. 1. Trend in Zimbabwe's elephant population estimates from 1989 to 2006. *Source*: Department of National Parks and Wildlife Management (1996), Dunham and Mackie (2002) and Government of Zimbabwe (2010).

Table 1. Trends in rhino (both black and white) populations (on both private and state land), numbers and percentages of rhinos poached annually between 1989 and 2010 in Zimbabwe and South Africa. *Notes*: n.a.–not available; dash (–) denotes not applicable. *Source*: Lindsey and Taylor (2011), Milliken and Shaw (2012), World Wildlife Fund Zimbabwe and Zimbabwe Parks and Wildlife Management Authority.

Country	Zimbabwe			South Africa		
Year	Population estimate	Poached	Percentage poached	Population estimate	Poached	Percentage poached
1989	1900	126	6.6	5410	0	0.0
1990	n.a.	172	–	5554	14	0.3
1991	n.a.	153	–	5828	5	0.1
1992	585	105	17.9	6116	18	0.3
1993	462	103	22.3	6820	14	0.2
1994	473	0	0.0	7336	27	0.4
1995	484	1	0.2	7524	14	0.2
1996	495	0	0.0	7670	6	0.1
1997	506	0	0.0	8100	6	0.1
1998	550	0	0.0	8410	12	0.1
1999	594	0	0.0	8580	13	0.2
2000	671	3	0.4	8800	12	0.1
2001	742	2	0.3	9450	9	0.1
2002	836	2	0.2	10400	25	0.2
2003	786	42	5.3	12470	22	0.2
2004	812	25	3.1	11310	12	0.1
2005	860	10	1.2	14390	17	0.1
2006	870	21	2.4	16490	36	0.2
2007	904	38	4.2	16700	13	0.1
2008	780	164	21.0	18750	83	0.4
2009	724	39	5.4	19810	122	0.6
2010	717	52	7.3	20400	333	1.6
Total poached	–	1058	–	–	813	–

The revenue accrued in the CAMPFIRE programs in Zimbabwe between 1989 and 2006 are shown in Fig. 2. The peak in CAMPFIRE revenue in 2003 was associated with the final funding by many donor agencies before they withdrew their funding. Consequently, a very large decline in CAMPFIRE revenue was recorded in 2004 and 2005. However, average CAMPFIRE revenues did not significantly differ before and after 2000 (t = –2.00, df = 16, P = 0.062).

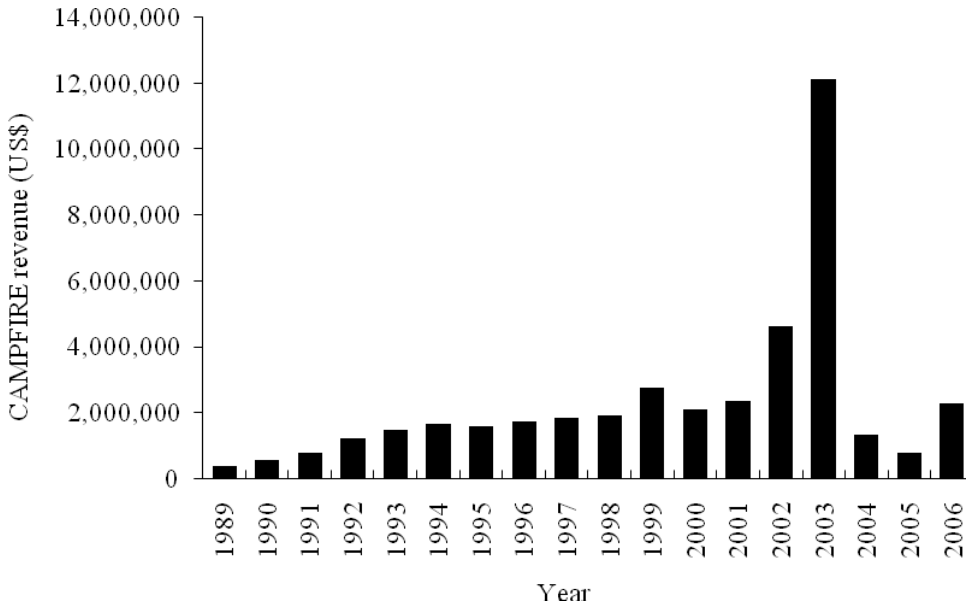

Fig. 2. Trends in Zimbabwe's CAMPFIRE revenue accrued between 1989 and 2006. *Source*: CAMPFIRE Association of Zimbabwe.

Wildlife conservation in Zimbabwe, 1989–2010

Ivory ban

In all three countries the ivory ban seemed to have played an important role. In the UK, Zimbabwe often did not play an active role in the frames but was only mentioned. Zimbabwe provided the clearest frames on Zimbabwe's position and in these articles Zimbabwe always played a central role throughout the years. Peaks in article frequencies co-occurred in USA

and UK, and these were encompassed by the peaks in The Herald (Zimbabwe), in particular in 1989 which was the start of the ivory ban, but also in 1997 and 1999, when the first international ivory sale after the ban was allowed (Fig. 3). As from 2000, the political situation started to play a central role in many of the articles. In the USA the ivory ban subject generally disappeared from the newspapers after 2002. In the UK, Zimbabwe's role in the ivory ban became smaller in the late 1990s but it did continue to produce a small number of articles and frames on Zimbabwe's position. In Zimbabwe, the majority of articles on the trade in ivory were published in the 1990s.

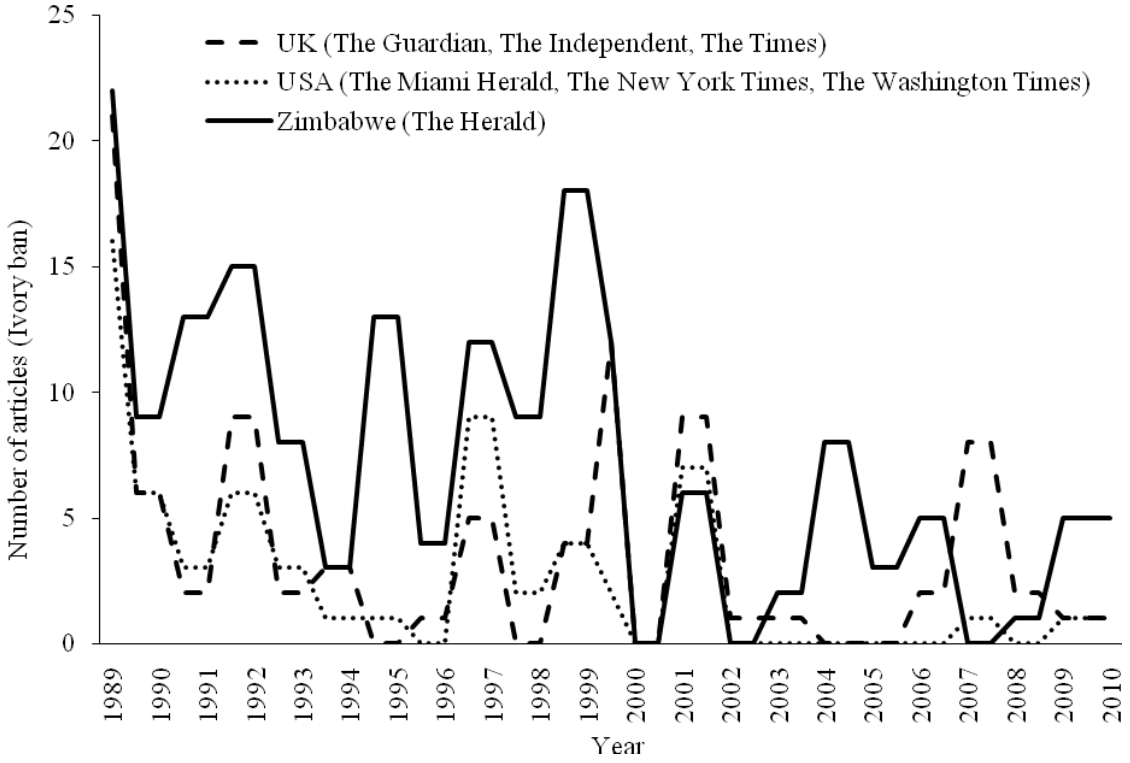

Fig. 3. Trends in sum of articles of all newspapers per country focusing on ivory ban, and featuring Zimbabwe, in the United Kingdom (UK), United States of America (USA) and Zimbabwe newspapers between 1989 and 2010.

Rhino protection

In all three countries the majority of articles on the rhino issues were published in the beginning of the 1990s, dropped in the following decade, and increased again after 2005 (Fig. 4). The increase of articles in the 1990s was associated with the start of rhino dehorning programs, creation of rhino protection areas, and the adoption of the "shoot-to-kill" policy in Zimbabwe. The disappearance of rhino articles between 1997 and 2006 was associated to the overall good protection of rhinos in the country. However, the rhino issue reappeared in the UK and Zimbabwe newspapers as from 2007, following increased rhino poaching in Zimbabwe. The UK and The Herald (Zimbabwe) published more articles compared to the USA newspapers.

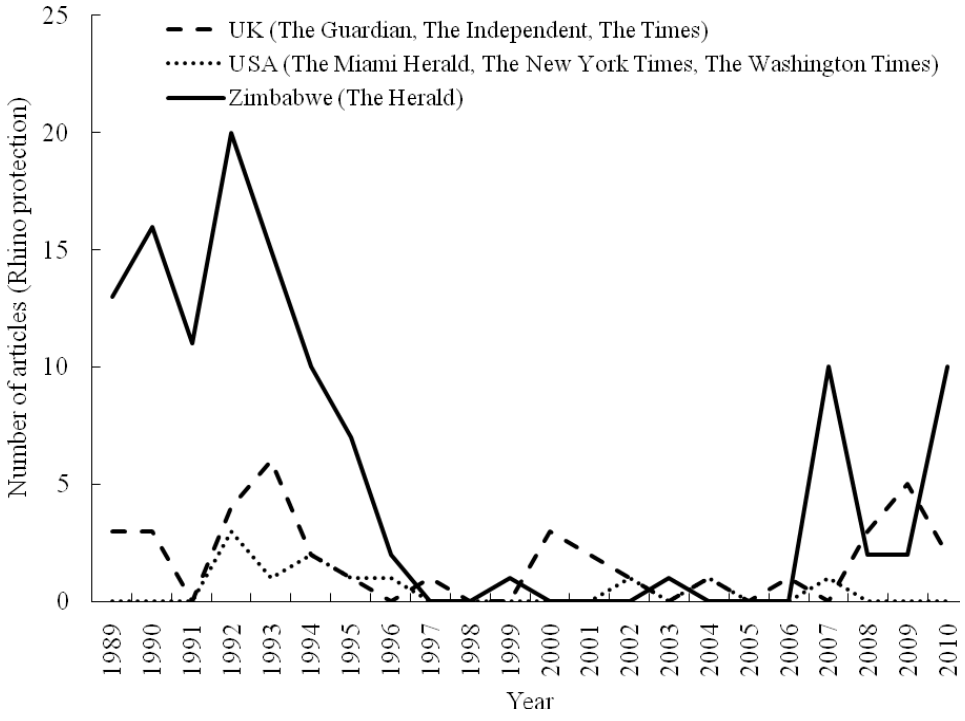

Fig. 4. Trends in the total number of published articles focusing on rhino protection and Zimbabwe in the United Kingdom (UK), United States of America (USA) and Zimbabwe newspapers between 1989 and 2010.

Wildlife conservation policy (CAMPFIRE)

In the UK, Zimbabwe's wildlife conservation policy played the smallest role; the issue was never the main subject in the articles. In the USA more in-depth frames surfaced and also more lead articles were published on the issue. In Zimbabwe a substantial number of articles were published on the topic throughout the years, all of which focused on CAMPFIRE. In all three countries the majority of the articles were published in the 1990s. The peaks in the Zimbabwe's articles were associated with the ivory sales (1998 and 2007) and the revenues received by the local communities from CAMPFIRE (1992, 1994 and 2005) (Fig. 5).

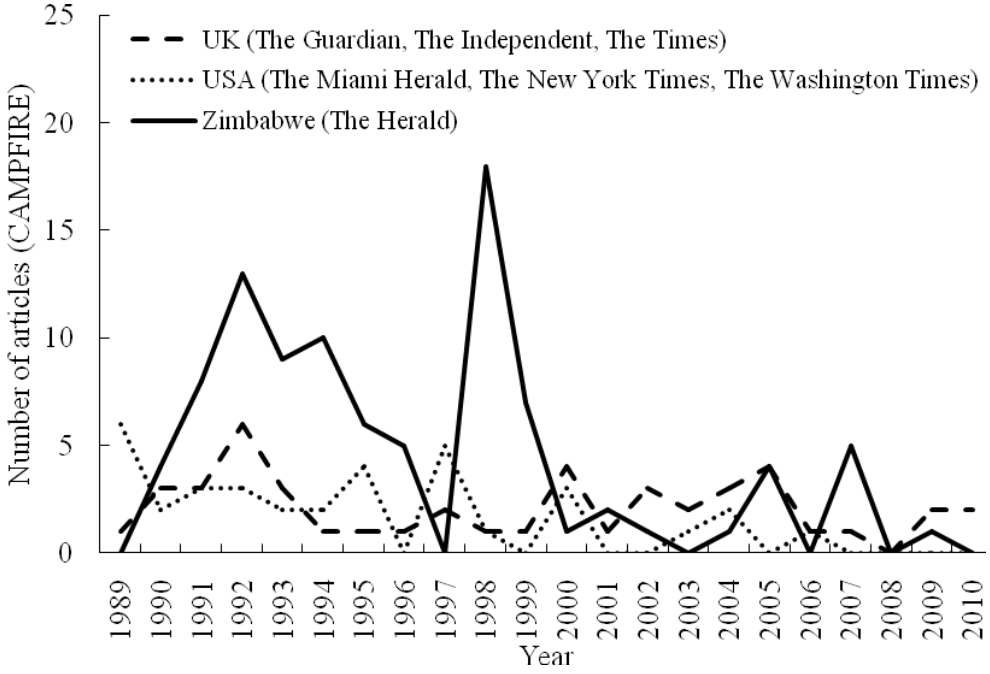

Fig. 5. Trends in the number of published articles focusing on Zimbabwe's wildlife conservation policy (CAMPFIRE), in the United Kingdom (UK), United States of America (USA) and Zimbabwe newspapers between 1989 and 2010.

Frame analysis of wildlife conservation in Zimbabwe, 1989–2010

Frames on ivory ban

Between 1989 and 1999: in all three countries the main frame that surfaced on articles on trade in ivory featuring Zimbabwe was the "opposing the ban" frame, e.g., *"Southern African states, such as Zimbabwe, Botswana and South Africa, have already declared their opposition to a ban, as their stocks of elephants are rising, allowing profitable culling for ivory, meat and leather"* (The Independent London, 10 October 1989, N. Cater). In all three countries two supporting frames on opposing the ivory ban surfaced: the "too many elephants" frame, referring to the argument that some countries in southern Africa including Zimbabwe had too many elephants: *"The country is bursting at its environmental seams at a time when much of the world is expressing alarm that the African elephant is on its way to extinction*" (The Miami Herald, 5 October 1989, R.T. Knight, Ridder News Service). The other frame was the "loss of income" or "income will be used for conservation by local people" frame, referring to the loss of income for conservation and local people because of the ivory ban. Overall, there were no differences in frames that were noted between the newspapers from the three countries between 1989 and 1999.

After 2000, the majority of the frames disappeared from the articles in the international papers and one overall blame frame, supported by sub-frames, started to dominate articles: the "political unrest and land reform" blame frame. Zimbabwe's political situation in general and its fast track land reform in particular were blamed for the deteriorating situation for wildlife conservation in Zimbabwe. For example: *"The UN rejected a request from Zimbabwe and Zambia to sell ivory under similar arrangements. Delegates said they were concerned that the two countries could not properly monitor ivory sales because of corruption and political instability"* (Washington Post, 13 November 2002, Reuters).

Frames on rhino protection

Between 1989 and 1999: in the articles on rhino protection and Zimbabwe, all newspapers framed the same main problem, i.e., the near extinction of the rhino, for example: *"The rhinoceros is one of the world's most endangered species, with only 9,000 left in the whole of Africa..."* (The Independent London, 12 March 1992, T. McCarthy). The main cause for the near extinction of the rhino was attributed to poaching: *"At the heart of the debate (how to save the rhino and elephant from extinction) lays the problem of poachers"* (The Guardian, 4 September 1990).

This frame came with different solutions or protection frames. Three dominant protection frames surfaced in all three countries. First, a "war" frame, accompanied by the "shoot-to-kill" frame given as a protection measure to stop the poaching of the rhino, for example: *"In some regions such as the Zambezi Valley dividing Zimbabwe and Zambia, it involves a shoot-to-kill war between poachers and game officials"* (The Washington Post, 9 February 1992, S. Taylor). Second, the "dehorning" protection frame, this conservation measure started to surface as a frame around 1992: *"Zimbabwe's game warden's start a huge campaign today to dehorn up to 300 black rhino's in a desperate bid to save them from the guns of the poachers"* (The Independent London, 1 June 1992, M. Cole). These "war" and "dehorning" protection frames surfaced in all three countries and played an important role as ways of rhino protection in the beginning of the1990s. The "dehorning" frame disappeared from the articles after a few years in all three countries. A third conservation frame that surfaced in all three countries was the "trade in rhino horn" frame, referring to a conservation measure by the Zimbabwe Government which was criticized in the UK and USA.

Differences emerged too. First, in Zimbabwe it appeared as if rhino protection was more or less under control, whereas in the international newspapers a constant reference was

made to the severity of the situation. Second, frames in the USA and Zimbabwe seemed to "personalize" the story more than the UK: names of people involved in the protection of the rhinos were mentioned in the USA and Zimbabwe, but not in the UK.

After 2000, there was a complete turnaround on the issue of rhino poaching in Zimbabwe after the mostly positive frames that were published in the 1990s in both the UK and USA. Similarly, the "political unrest and land reform" blame frame became dominant. For example: *"Six months of violent land invasions in Zimbabwe have opened the door to a wave of poaching that has endangered rare animals in a nation that until recently has been acclaimed as one of Africa's most scrupulous defenders of wildlife"* (Washington Post, 27 May 2000, R. Herbert).

Frames on wildlife conservation policy (CAMPFIRE)

Between 1989 and 1999: in both the UK and USA a similar main frame surfaced on CAMPFIRE, namely the "sustainable use of wildlife" frame. This frame was associated with two sub-frames. First, the "human-elephant conflict" sub-frame, for example: "*Mr. Mandizvidza is far too scared of elephants, which kill at least one person a year in this district 100 miles north of Harare, to stay up all night banging a pot to drive them away*" (The New York Times, 12 April 1997, S. Daley). Second, the "income for rural communities" sub-frame, for example: "*Zimbabwe is helping to pioneer this. It gives communities the legal right to manage the wildlife in their areas, as long as they show that they can do it. The communities then work out their own ways of profiting from it, in consultation with the wildlife department. As the communities benefit from the wildlife, they take care to conserve it: poaching has fallen dramatically*" (The Independent London, 10 May 1998, G. Lean). These frames showed why Zimbabwe's wildlife conservation policy was necessary and

working. In Zimbabwe similar frames were found: "people should benefit from their natural resources" and "wildlife is a nuisance."

Some differences were noted between the newspapers from the three countries. The articles and frames in the USA were more detailed than in the UK. In Zimbabwe, the articles were typically very small scale and locally oriented; this caused many different frames to occur that did not surface in the international newspapers. The main frame in Zimbabwe was the "benefits from CAMPFIRE" frame, reporting how participants of CAMPFIRE benefit from the program. For instance: *"Beitbridge Rural District Council has distributed US$28,000, part of the CAMPFIRE proceeds from natural resources management last year…"* (The Herald, Zimbabwe, 19 September 2009, Herald Reporter). Moreover, in both the USA and Zimbabwe, some articles "personalized" the issue by naming the person or communities that benefited from CAMPFIRE or suffered from wildlife. In the UK newspapers no reference was made to a person or community.

After 2000, the "political unrest and land reform" blame frame also became dominant in the articles on CAMPFIRE. Although the state-owned wildlife reserves were not officially included in the fast track land reforms, some areas were affected at least according to the articles. For example, in the articles on CAMPFIRE in the UK newspapers, the following quote refers to the consequences of the inclusion of some of the wildlife reserves in the fast track land resettlement. In the case of Gonarezhou National Park, southern Zimbabwe: "*It was disastrous for the park: wild animals were slaughtered, bush and trees burnt for cultivation of crops and building of houses, and wildlife habitat destroyed. Nor was it particularly beneficial for the people: the soil where they settled was poor, rainfall was minimal and the mixing of cattle and wildlife exposed both to diseases such as foot and mouth"* (The Guardian, 3 April 2002, L. McGregor).

Overall, not all three issues showed the change in the frames equally clear. In the articles on the ivory ban in the UK and USA, the change only showed in one or two articles. In the USA, few articles with the ivory ban issue were published between 2000 and 2010. The change of frames in newspapers in both countries became clearer in the articles on the rhino and CAMPFIRE issues. Table 2 shows the summary of main frames before and after 2000.

Table 2. Summary of frames that appeared in the study newspaper articles for the period 1989–1999 and 2000–2010 on wildlife conservation in Zimbabwe.

Issue	Period and Frames	
	1989–1999	2000–2010
Ivory ban	i) Opposing the ban ii) Too many elephants iii) Loss of income/ income will be used for conservation by local people iv) Increase in poaching v) Us *vs.* them	Frames that appeared on wildlife conservation in international newspapers: i) Political unrest and land reform ii) Blaming the international media iii) Us *vs.* them
Rhino protection	i) Near extinction of the rhino ii) War iii) Shoot-to-kill iv) Dehorning v) Trade in rhino horn vi) Illegal possession of rhino horn and trade vii) Five-year or big fine	
Wildlife conservation policy (CAMPFIRE)	i) Sustainable use of wildlife ii) Human-wildlife conflict iii) Income for rural communities iv) Benefits from CAMPFIRE v) Us *vs.* them	

Discourse coalitions, blame frames and us vs. them frames, 1989–2010

Between 1989 and 1999: in all three countries, the articles on the ivory ban and CAMPFIRE showed the us *vs*. them frame, i.e., "utilizers vs. protectionists", hence two discourse coalitions on the ivory ban and CAMPFIRE, respectively. These two discourse coalitions reflect two different ways of wildlife conservation policies: the protection of wildlife as a way of conservation, "protectionism", and the utilization of wildlife as a way of conservation, "utilitarianism." For example: *"On the face of it, this is a head-on collision between those who believe that only drastic measures can save the elephant from extinction in the face of a voracious ivory trade, and those who argue that an all-out ban on killing would in reality put some subsistence economies at even greater risk. Members of the latter group also hotly contest the extent to which the species is beleaguered"* (Times London, 2 October 1989, J. Raath and A. Franks).

USA and Zimbabwe's articles showed a strong preference for the utilitarian discourse, particularly in the beginning of the 1990s, in which Zimbabwe played a prominent role. In these articles blame frames surfaced against Kenya's preservation policy in the 1990s. "*Somebody is taking away something that belongs to us. Kenya failed to manage its elephants, Tanzania failed and now it is we who are being punished" (Cde. Ephraim Chafesuka, Chairman of the Guruve District Council)* (The Herald, Zimbabwe, 3 October 1989, A. Raphael). The similar discourse coalitions in the two issues can be explained by an overlap between these two issues. Ivory provides income for CAMPFIRE, and so does hunting, both of which do not fit in the "protectionist" philosophy of wildlife protection. In contrast to the CAMPFIRE and ivory ban articles, no discourse contrasts surfaced in the articles on rhino in any of the countries. Moreover, although newspapers frame ideas against the shoot-to-kill policy (as part of frame parity outlined below), this did not lead to a coalition.

Between 2000 and 2010, the USA and UK media reduced the parity in their framing of Zimbabwe: the articles no longer focused on Zimbabwe as an example of a state with good wildlife conservation policy or practices in the international newspapers. They focused instead on the negative effect that land reform had on wildlife conservation. In Zimbabwe, the discourse on the ivory ban remained the same between 2000 and 2010. For example: *"...while countries, such as Kenya, were clearly losing the battle for conservation of the elephant due to inadequate investment in anti-poaching operations, the four SADC states have increasing animal population" (Mr. Stephen Kasere, CAMPFIRE Director)* (The Herald, Zimbabwe, 20 March 2000, Herald Reporter).

One other blame frame occurred in 2010, in which the Zimbabwean Government blamed the international media, western governments and non-governmental organizations for bringing negative reports about Zimbabwe wildlife management in the media. For example: *"...the Convention of International Trade in Endangered Species should realize that Zimbabwe has two faces: that of what is happening on the ground and that what is peddled by hostile foreign media"* (The Herald, Zimbabwe, 10 February 2010, Herald Reporter). This resulted in an "us *vs.* them" frame.

Frame parity, 1989–2010

The articles on the ivory ban from the UK produced the most frame parity, followed by the USA. Zimbabwe showed the least frame parity, particularly after 2000. Almost all Zimbabwe's articles solely produced frames opposing the ivory ban. The majority of the USA articles opposed the ban, but showed more frame parity than in the articles in Zimbabwe (Fig. 6). The UK showed the most frame parity with many articles producing frames and counter frames for each of the discourses, for instance: *"The arguments for and against banning the ivory trade should be judged by one criterion only. That is: which policy is most likely to save*

the African elephant from extinction" (Times London, 12 October 1989, J. Dettmer). In contrast, lack of frame parity was evident in the following quote: *"...if you remove the elephant (from international trade), you kill us." Dr. Willi Nduku, Director of National Parks and Wildlife Management"* (The Herald, Zimbabwe, 11 October 1989, Herald Reporter).

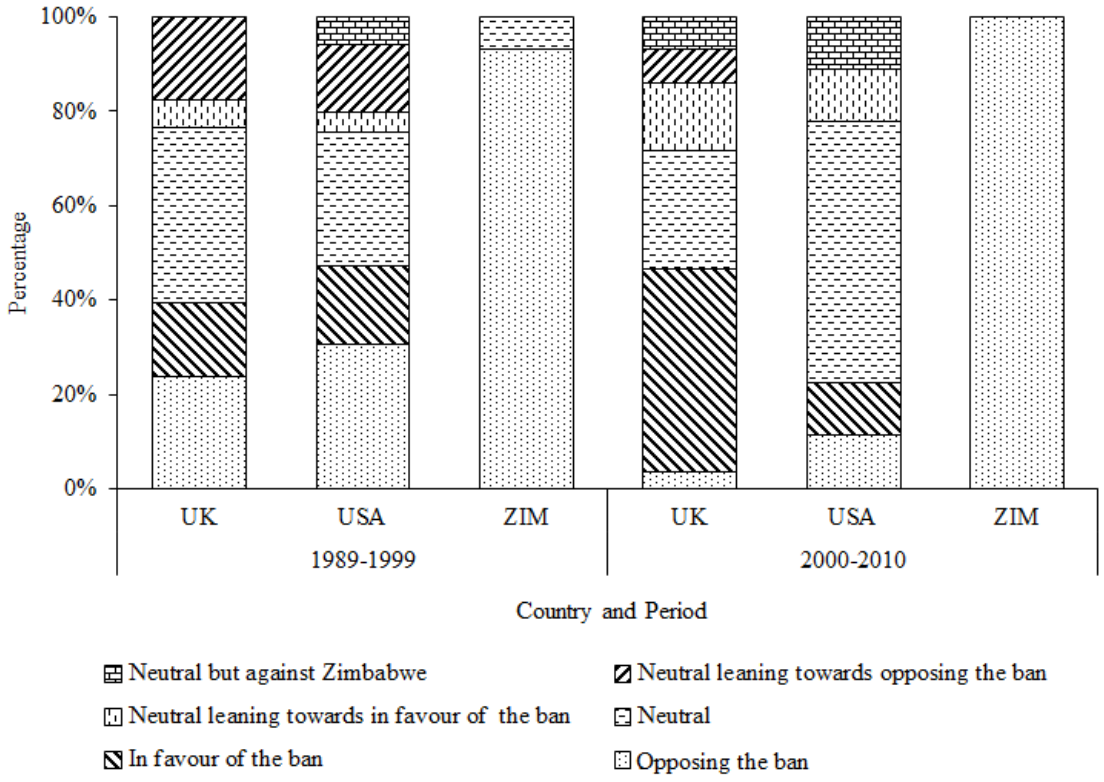

Fig. 6. Contribution of published newspaper articles to frame parity on the ivory ban issue. *Notes*: UK–United Kingdom, USA–United States of America and ZIM–Zimbabwe. Number of newspaper articles: 1989–1999 (UK=51, USA=49, ZIM=126) and 2000–2010 (UK=28, USA=9, ZIM=42).

UK and USA newspapers did produce some frame parity on articles on the rhino issue between 1989 and 1999 (Fig. 7). These newspapers produced counter frames for the "dehorning of the rhino" frame, for example: *"They claim it is inhumane, and they point out that sometimes poachers still kill dehorned rhino's…"* (The Washington Post, 2 April 1995, R. Slusser) and for the "shoot-to-kill" protection frames: *"But what nobody can justify is the present Zimbabwe's Government's shoot to kill strategy against poachers: some 57 poachers were killed"* (The Guardian, 4 September 1990). In contrast, Zimbabwe produced the least frame parity, except for two articles on the rhino horn trade, including: *"...the resumption of legal rhino horn trading would make it almost impossible to control the trade in poached horn, especially in Asia"* (The Herald, Zimbabwe, 30 April 1991, Herald Reporter). However, after 2000, the majority of articles that appeared in the UK and USA newspapers on rhino protection in Zimbabwe lost frame parity, as the articles became one sided with no counter frames being produced (Fig. 7). Only the "political unrest and land reform" blame frame remained in the UK and USA. Similarly, the Zimbabwean newspaper lost frame parity on rhino protection articles.

Fig. 7. Contribution of published newspaper articles to frame parity on rhino protection in Zimbabwe. *Notes*: UK–United Kingdom, USA–United States of America and ZIM–Zimbabwe. Number of newspaper articles: 1989–1999 (UK=20, USA=14, ZIM=95) and 2000–2010 (UK=18, USA=4, ZIM=25).

In the CAMPRIRE articles all three countries' newspapers showed some frame parity, particularly between 1989 and 1999 (Fig. 8). Zimbabwe showed some frame parity when framing the problems with CAMPFIRE even after 2000. The UK had the most frame parity in the beginning of the 1990s, when both discourses were framed quite clearly. For example, in the following quote from Richard Leakey, the then Director of Kenya's Wildlife Service: "*He (Richard Leakey) is scathing about Zimbabwe, where culling and licensed shooting by amateur hunters have already been introduced"* (The Independent, 26 October 1992, K. Graves). The USA showed the least frame parity on CAMPFIRE issues before 2000. The majority of the articles showed a clear preference for Zimbabwe's wildlife conservation

policy and hardly any other or critical frames were produced. However, after 2000, all articles that appeared in the UK and USA newspapers on CAMPFIRE lost frame parity, as the articles became one sided with no counter frames being produced (Fig. 8). Only the "political unrest and land reform" blame frame remained in the UK and USA. On the other hand, only the Zimbabwean newspaper showed some frame parity on CAMPFIRE after 2000.

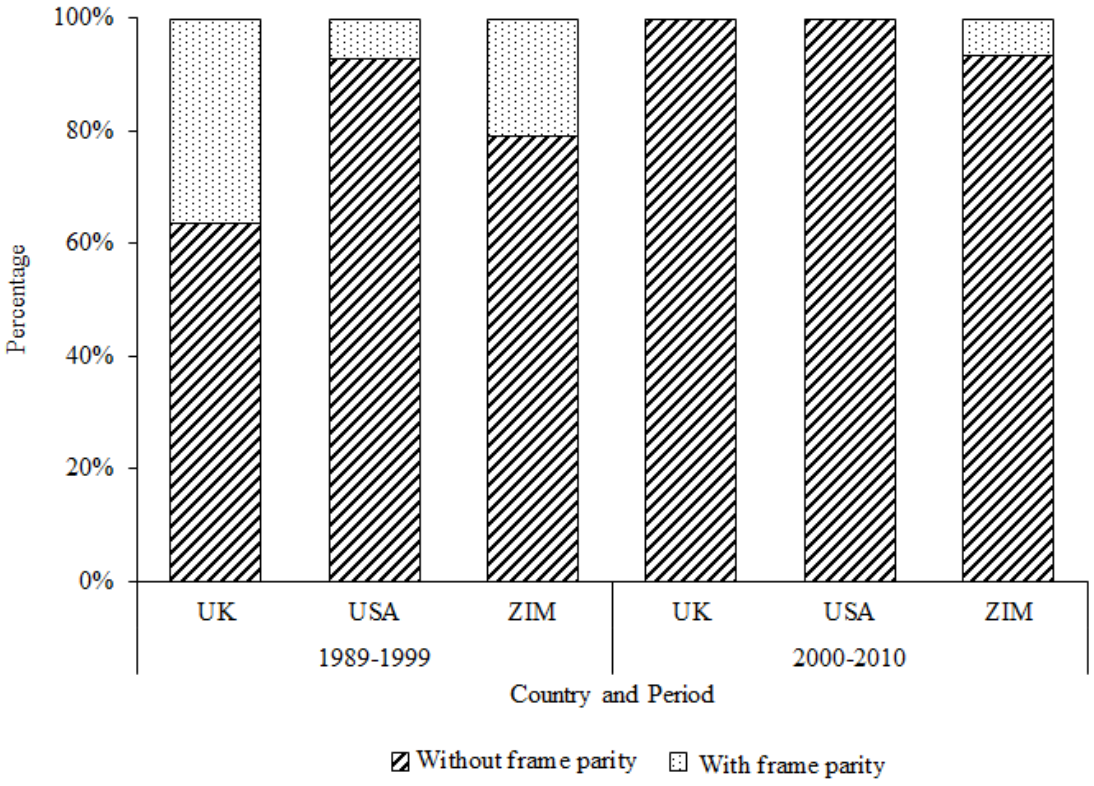

Fig. 8. Contribution of published newspaper articles to frame parity on CAMPFIRE in Zimbabwe. *Notes*: UK–United Kingdom, USA–United States of America and ZIM–Zimbabwe. Number of newspaper articles: 1989–1999 (UK=22, USA=28, ZIM=81) and 2000–2010 (UK=23, USA=7, ZIM=15).

Discussion

We started this research by wondering if the misrepresentation of wildlife conservation in Zimbabwe in the international media could be explained by a possible spill-over effect. In particular, if the framing of political issues had influenced the framing of non-political issues leading to possible metaphors and myths in relation to wildlife conservation. Our research showed indeed the framing of political issues spilled over in the framing of non-political issues in which wildlife conservation was then metaphorically represented as a disaster or crisis, despite empirical evidence to the contrary. Hard data considering two iconic wildlife species, the elephant population in Zimbabwe significantly increased whereas the rhino population remained stable despite severe poaching between 1989 and 2010. Moreover, although CAMPFIRE revenue did not change significantly before and after 2000, a decline in CAMPFIRE revenue was recorded between 2004 and 2005 following the withdrawal of donor support from Zimbabwe. Recent evidence suggests that this is due to law enforcement in state-owned wildlife reserves, for example in Gonarezhou National Park, which was strengthened after 2004 following the structural reforms in the wildlife authority in Zimbabwe and which likely helped reduce the level of illegal wildlife exploitation (Gandiwa et al. 2013b). However, in the international media, it appears as if there has been massive decline of wildlife across Zimbabwe (Shaw 2008). Although some articles attempted to make a distinction between state-owned wildlife reserves which were less affected by the land reforms and the private-owned game reserves which were largely negatively affected by the land reforms since 2000 (Lindsey et al. 2011a; Lindsey et al. 2013), the majority of the articles did not.

In the 1990s, the majority of the newspaper articles appeared to agree that wildlife conservation in Zimbabwe was successful and Zimbabwe was also seen as one of the leading countries in wildlife conservation. After 2000, the international media lost interest in wildlife

conservation in Zimbabwe as evidenced by the decline in published articles but the few articles that were published framed wildlife conservation in Zimbabwe as unsuccessfully making explicit references to the internal politics. Our results showed that after 2000, the focus of the articles on wildlife conservation in Zimbabwe particularly in the UK and USA newspapers shifted to the political situation in the country, and particularly on the suffering of people and wildlife poaching. Consequently, Zimbabwe was no longer seen as a good example or leader in wildlife conservation and most of the blame was given to the political unrest and land reforms in the country. This demonstrates a spill-over effect in international newspapers on Zimbabwe's wildlife conservation.

This appears akin to a spill-over effect following a natural disaster. Current disaster literature, which primarily focuses on natural disasters, seems to agree on the fact that spill-over of frames does occur in the media in times of natural disasters and that this can influence how a disaster is addressed and handled (Goltz 1984; Stock 2007; Jacob et al. 2008; Morton et al. 2011). For instance, one frame contributing to myth formation that appears to be playing a prominent role in the disaster literature is "looting" (Goltz 1984; Quarantelli 1994; Barsky 2006; Tierney et al. 2006). In the present research, "looting" seemed to appear in the frames not in the traditional way, but the bush equivalent, i.e., poaching for, ivory, rhino horns or bushmeat. Another frame that contributed to myth formation that appeared to be playing a role was the frame of 'social disorganization' or 'self-interested reactions' leading to the disappearance of social cohesion in crisis times as recorded in the *Titanic* disaster (Frey et al. 2011). In present research, this frame appeared in articles reporting on land reform beneficiaries as squatters settling (illegally) in the private and state game reserves, a form of social disorganization that caused many problems for the owners or management according to the articles.

As result of the metaphors and myths on wildlife conservation in the international media, international donors significantly withdrew their support when the land reforms started. Both the UK and USA were major donors to Zimbabwe but as the UK and USA relations with Zimbabwe deteriorated since 1997 both these countries stopped developmental aid, funding and also imposed sanctions on Zimbabwe following the country's land reforms. Consequently, following Zimbabwe's land reforms in 2000, some donor agencies and international media reacted with a "hands off" reaction on issues related to wildlife conservation in Zimbabwe (Mtsambiwa 2003). For example, non-governmental organisations such as the United States Agency for International Development which was actively involved in the CAMPFIRE initiative since its inception in 1989 and Canadian International Development Agency which was involved in the program prior to 2000 withdrew their support following the Zimbabwean Government's implementation of the controversial fast track land reform programme in 2000 (Mapedza 2009). Surprisingly, our results showed that CAMPFIRE revenues steadily increased between 1989 and 2003, and was only followed by a big decline in 2004 and 2005, subsequently followed by an increase in 2006. The high level of CAMPFIRE revenue in 2003 could be a result of the carry-over effect of the foreign aid which Zimbabwe received up to 2002/2003 which was followed by the drop in revenues in 2004 and 2005. However, income from sport-hunting in both state owned reserves and some private areas was least affected by the political crisis in Zimbabwe (Lindsey et al. 2009a; Gandiwa et al. 2013b) which resulted in some revenue being accrued by the CAMPFIRE communities after 2003.

The "hands off" reaction also showed in the international media, and even more so in the USA than in the UK. This could have been caused by differential historical relations. Unlike the UK, the USA has no political historical ties to Zimbabwe so when the USA strongly condemned the Zimbabwean Government for its land reforms, wildlife conservation

was no longer newsworthy for USA newspapers whereas interest in UK newspapers continued. Interestingly, even in the Zimbabwe newspaper, the number of wildlife conservation related articles decreased after 2000. Yet, the issues continued to play an important role in the media, which could be explained by the fact that wildlife utilization in CAMPFIRE areas continued to directly affect local communities (Taylor 2009).

Conclusion

Our study showed that there was indeed a spill-over from the frames of the political upheaval in Zimbabwe into frames on wildlife conservation after the political changes in 2000 following the land reforms. The recorded spill-over effect in UK and USA newspapers on Zimbabwe's wildlife conservation could be a result of the changes in political and historical relations between Zimbabwe, UK and USA. Throughout the 1990s politics did not play a visible role in the frames on wildlife conservation in Zimbabwe. However, after 2000 one overall blame frame started to dominate, i.e., the "political unrest and land reform" blame frame. The political situation and land reform were blamed in the restrictions in ivory trade, poaching of rhinos and in the reduction of CAMPFIRE revenues. However, our results showed that elephant populations increased, rhino populations remained stable, and, the CAMPFIRE revenues were not severely affected by the land reforms over the study period. It does seem that the spill-over effect influenced donors and other important organizations to withdraw their funding to wildlife conservation in Zimbabwe.

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CHAPTER 6: Synthesis

Edson Gandiwa

Introduction

My study represents a novel attempt to understand wildlife conservation issues through interdisciplinary research (Marzano et al. 2006; Giller et al. 2008), by combining research methods from both the social and natural sciences. The main objective of my study is to generate information that would 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. Moreover, I investigated the framing of wildlife conservation in the mass media following a political crisis and economic decline. Fig. 1 shows the original study model and the different relations to processes controlling large herbivore populations in terrestrial ecosystems. In Chapter 2, I investigated the role of rainfall (natural control) in influencing large herbivore populations in semi-arid savanna ecosystems. In Chapter 3, I investigated the role of human hunting (human induced top-down control) of large herbivore populations and associated human controls, in particular, law enforcement. In Chapter 4, I addressed the effectiveness of CAMPFIRE and human-wildlife conflicts in areas adjacent to a state protected area. Moreover, in Chapter 5, I explored an emerging issue related to wildlife conservation, namely media framing of wildlife conservation, following a political crisis and economic decline. Each chapter has in turn shed new light on natural and human-induced controls, effectiveness of CAMPFIRE and human-wildlife conflicts and media framing of wildlife conservation. In this Chapter, I will integrate and synthesise the major findings of my study, discuss the scientific contributions and practical implications of my study.

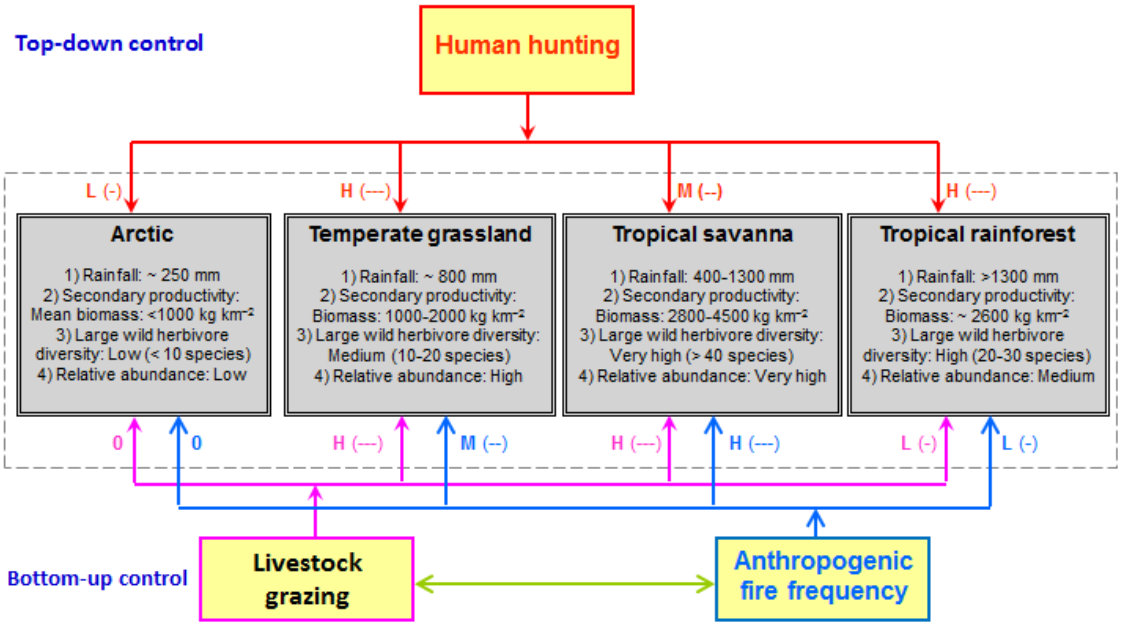

Fig. 1. A schematic representation indicating the top-down and bottom-up controls of human activities (at global biome level) particularly on wild large herbivore community in the arctic, temperate grasslands, tropical savannas and tropical rainforests. *Data sources*: Barnes and Lahm (1997), Du Toit and Cumming (1999) and Sala et al. (2001). *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.

Integration of main findings

Natural control

In Chapter 2, I demonstrated that rainfall, in particular droughts, plays a major role in influencing large herbivore population dynamics in semi-arid savanna ecosystems with high rainfall variability. Droughts are associated with a reduced primary production (Drent & Prins 1987; Prins & Loth 1988; Vicente-Serrano et al. 2013), which results in large animal die-offs due to forage shortages and also reduced surface water availability (Knight 1995; Foley et al.

2008; Duncan et al. 2012). I recorded evidence of a weak synchrony in the occurrence of droughts and wet years in areas adjacent to the Gonarezhou National Park between 1970 and 2009. Populations of seven 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, suggesting a synchrony in large herbivore population development between these two protected areas. 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. Overall, annual rainfall appeared not to influence large herbivore populations on the long term.

Top-down human control

Issues of illegal hunting have received considerable attention in recent years, particularly, in the tropical rainforest and savanna ecosystems (Fa & Yuste 2001; Brashares et al. 2004; Barrett & Ratsimbazafy 2009; Hayward 2009; Lindsey et al. 2011a; Nielsen 2011; Lindsey et al. 2013; Gandiwa et al. 2014), therefore, advancing our understanding of the negative impacts associated with human bushmeat hunting (top-down human control) on animal communities and how law enforcement can influence such human bushmeat hunting in times of political crisis and economic collapse is important (Chapter 3). I 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 (Fa & Yuste 2001; Brashares et al. 2004; Holmern et al. 2006; Willcox & Nambu 2007; Kümpel et al. 2010; Macdonald et al. 2012). 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, 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 (Mombeshora & Le Bel 2009; Gandiwa et al. 2011).

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. 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. 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 (Wato et al. 2006; Tumusiime et al. 2010; Becker et al. 2013). 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, I 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. My work, therefore, confirms that law enforcement is an important component of

wildlife conservation in protected areas (Leader-Williams 1996; Jachmann & Billiouw 1997; Holmern et al. 2007; Fischer 2008). 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 (Chapters 2 and 3). Further, there was no evidence in Gonarezhou National Park to suggest that illegal hunting had increased following the country's political crisis and economic collapse between 2000 and 2008. Similarly, my study respondents also attributed the perceived decline in illegal hunting between 2000 and 2010 to increased law enforcement by the wildlife authority. This is in contrast to the media reports on general increase in illegal hunting across wildlife areas in Zimbabwe since 2000 (Chapter 5).

Missing elements in the original model

The original research model (Fig. 1) outlines the human-induced top-down and bottom-up controls of large herbivore populations in terrestrial ecosystems. However, the model did 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.

Wildlife conservation: policy instruments, incentives and provisions

The results I presented in Chapter 4 suggest that human-wildlife conflicts are common even in communities with integrated conservation and development projects (ICDPs) as reported by other authors (Michalski et al. 2006; Anthony et al. 2010; Gore & Kahler 2012). ICDPs play an important role in reducing human-wildlife conflicts through enabling communities to actively participate and derive economic benefits from natural resources management (Child 2000; Child & Chitsike 2000; Prins et al. 2000; Heitkönig & Prins 2009; Torquebiau & Taylor 2009). Community benefits under CAMPFIRE include infrastructure development, employment opportunities, cash dividends and a well-informed community on wildlife management issues and practices (Chapter 4).

Of particular importance was the perceived increase in human-wildlife conflicts as a result of increasing wildlife populations, e.g., elephant, as also reported in Chapters 2, 3 and 5. Similar, perceived increases in human-wildlife conflicts associated with increasing wildlife populations have been reported in Zimbabwe (Mutandwa & Gadzirayi 2007). 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 on how to manage wildlife, income and human-wildlife conflicts.

Contextual factors, such as size (area) of the community, human population density and previous success of the CAMPFIRE programs across the four local communities appeared to influence the perceived effectiveness of CAMPFIRE programs and attitudes towards problematic wildlife species in my study. 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

(Chapter 5) 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 (Chapter 3), 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 (Balint & Mashinya 2006; Balint & Mashinya 2008). Low response rate incidences of human-wildlife conflicts to some extent led to the poisoning or hunting of problem animals as also recorded in Chapter 3. Carnivores, e.g., leopard, lion and spotted hyena, 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 (Gandiwa 2011; Kalaivanan et al. 2011; Mateo-Tomás et al. 2012).

More favourable attitudes towards wildlife appeared to be associated with success of CAMPFIRE programs. 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 (Gillingham & Lee 1999; Scanlon & Kull 2009; Karanth & Nepal 2012).

Decision-making and framing processes

In Chapter 5, I 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, results presented in Chapters 2 and 3 were at odds with the image of Zimbabwe mostly in the international media, thus I developed an interest 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, I demonstrated in Chapter 5 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, I concluded that a spill-over effect from a political-related phenomenon, i.e., land reforms, to a non-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 (Chapters 2, 3 and 5; Valeix et al. 2008; Chamaillé-Jammes et al. 2009; Dunham 2012), whereas major wildlife declines were reported to have occurred in private-owned wildlife ranches or conservancies since the 2000 land reforms (Chaumba et al. 2003b; Wolmer et al. 2004; Lindsey et al. 2011a). 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 Fig. 2.

Scientific contributions

I have generated information that contributes to scientific knowledge in several ways from my study. First, my study contributes to the existing body of knowledge on the importance of rainfall in the natural control of large herbivore populations in savanna ecosystems. Rainfall is a key driver of primary production in terrestrial ecosystems (Coe et al. 1976; East 1984; Prins & Loth 1988) and thus its influence on large herbivore population developments. As Fig. 2 shows, large herbivore populations in semi-arid savanna ecosystems appear to be highly sensitive to high rainfall variations, as suggested by the decline of large herbivore populations in Gonarezhou National Park. This is also in line with previous studies which have reported that ecosystems with high rainfall variations tend to display nonequilibrium dynamism (Ellis & Swift 1988; Illius & O'Connor 1999, 2000). In contrast, I do judge it to be likely that rainfall variability has less negative impacts on the other terrestrial ecosystems. Second, my study has generated new understanding on the relationship between illegal hunting (top-down human control) and law enforcement in a savanna ecosystem. I have shown that the impact of illegal hunting on large herbivore populations in a savanna ecosystem is influenced by policy instruments (Fig. 2) and also the political situation and economic status of a country. Overall, I did conclude that law enforcement does not necessarily decrease in a situation of political instability and economic decline.

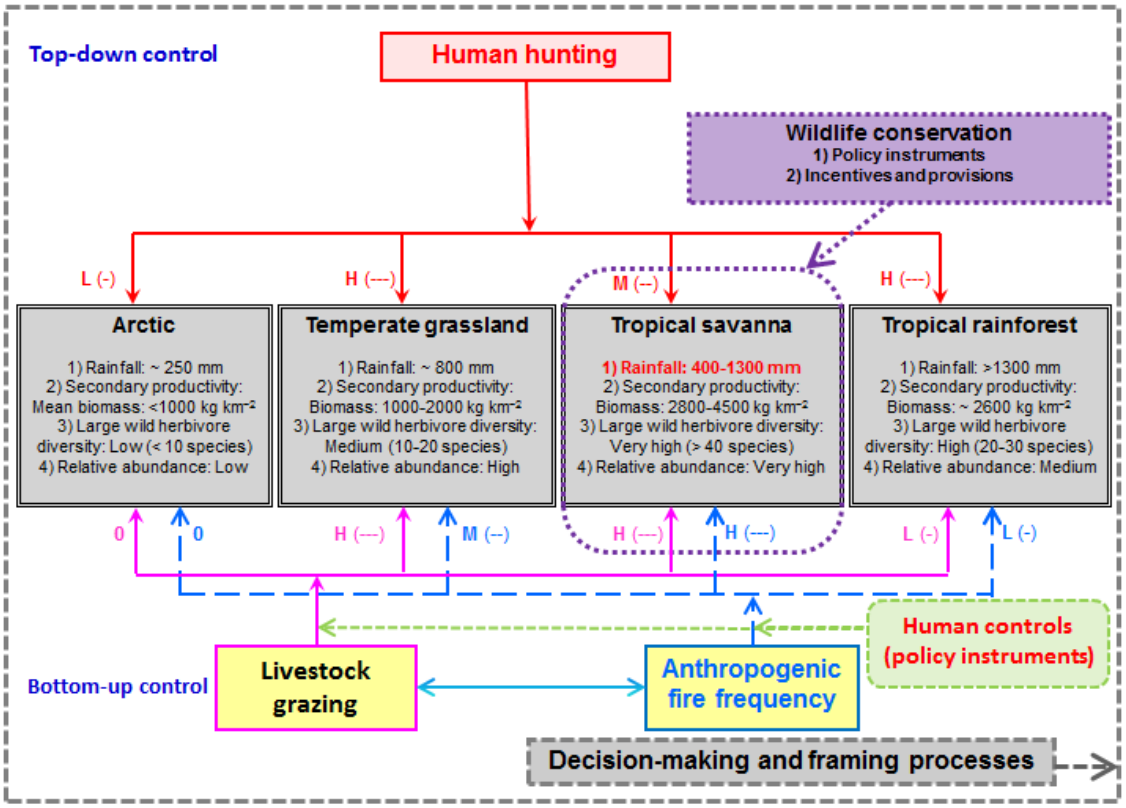

Fig. 2. An adapted schematic representation indicating the natural and human-induced top-down and bottom-up controls (at global biome level) particularly on wild large herbivore communities in the arctic, temperate grasslands, tropical savannas and tropical rainforests. Improvements to the original model (Fig. 1): i) rainfall acts as a natural control in the tropical savanna (highlighted in red and bold); ii) 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 iii) decision-making and framing processes about terrestrial ecosystems and wildlife conservation influences societal debates and wildlife management systems. *Data sources*: Barnes and Lahm (1997), Du Toit and Cumming (1999) and Sala et al. (2001). *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.

Third, my study has contributed to our current understanding of community-based wildlife management in areas near protected areas with growing wildlife populations. In particular, I have shown that people still experience high levels of human-wildlife conflicts in ICDP areas, such as CAMPFIRE, despite the incentives that local people receive or other policy instruments aimed at enhancing wildlife conservation. These human-wildlife conflicts potentially result in local people having negative attitudes towards problematic animals. Interestingly, my study has shown that communities with effective CAMPFIRE programs are associated with a decline in human-wildlife conflicts. Moreover, the involvement of local people in decision making related to community-based natural resources conservation was identified as important in the overall success of CAMPFIRE programs. I deduce that my study findings support the increasing call for devolution of decision making powers to local communities in ICDPs (Rihoy & Mugaranyanga 2007). Fourth, my study has generated new knowledge on the framing of wildlife conservation in the mass media in changing environments following a political crisis and economic decline. I deduced that a spill-over effect could occur from politically related issues to non-political issues, such as wildlife conservation, resulting in the misrepresentation of wildlife conservation issues in the international media.

Practical implications

Science-society interaction

I have 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. I deduce from my findings that my study provide an in-depth understanding of the discrepancy in the public image or wildlife conservation debate and the reality on the ground on wildlife conservation in Zimbabwe. Moreover, based on my study findings, I deduce 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 political related issue into a non-political issue of wildlife conservation (Chapter 5).

The media often neglect certain angles or frames of stories or neglect to provide evaluations of related events or issues (Entman 2004). 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 (Ferrier & Larson 2012). There is need to address the negative image of wildlife conservation in Zimbabwe through: i) ensuring that appropriate information is given in the international media so as to allow for support to conservation efforts by the international donors; ii) 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 iii) 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 my study is important in the societal arenas particularly in negotiations relating to natural resource use (Giller et al. 2008) and resource protection under the CAMPFIRE programs.

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. In Chapter 2, I recorded that wet and drought occurrences can vary within 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 (Chapter 4). In addition, transboundary management of large herbivores (Van Aarde & Jackson 2007) would also allow animals to move to less affected areas during droughts.

From my study findings, I deduce that snaring becomes a major illegal hunting method with increasing law enforcement efforts (Chapter 3). Similarly, I inferred from my findings that 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 (Chapters 3 and 4) 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 IUCN Red List.

Furthermore, I inferred from my study that a high involvement of local people in decision making is important for the overall perceived effectiveness of CAMPFIRE programs (Chapter 4). Therefore, by ensuring that local people genuinely participate in community-based conservation programs, policy makers and wildlife managers may, therefore, need to develop structures and policy instruments that enable local people to fully participate in conservation programs. 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.

Conclusion

My study has made a number of contributions in understanding the influence of rainfall, particularly droughts, on large herbivore populations in savanna ecosystems (Chapter 2). Wet and drought occurrences 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. Political crisis and economic collapse was shown not to necessarily lead to increased illegal hunting in situations where law enforcement is strengthened (Chapter 3); 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 (Chapter 4). 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 non-politically related issues (Chapter 5). To conclude, I therefore suggest 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.

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Summary

Wildlife conservation in terrestrial ecosystems requires an understanding of processes influencing population sizes. Top-down and bottom-up processes are important in large herbivore population dynamics, with strength of these processes varying spatially and temporally. However, up until recently the role of human-induced top-down and bottom-up controls have received little attention. This is despite the fact that almost all terrestrial ecosystems are influenced by human activities thereby likely altering the natural control of animal populations. Therefore, in this thesis, the role of natural and human-induced controls in influencing large herbivore populations and how human controls (i.e., policy instruments, incentives and provisions) influence human activities and wildlife conservation in a semi-arid African savanna ecosystem are investigated. This study primarily focuses on Gonarezhou National Park (hereafter, Gonarezhou), Zimbabwe and adjacent areas. Zimbabwe experienced an economic crisis and political instability between 2000 and 2008 following the land reforms that started in 2000 which were widely covered in the mass media.

The results indicated a weak synchrony in rainfall and drought occurrence (natural bottom-up process) in areas within the same "climatic" region, and variable responses of large herbivore species to the 1992 severe drought with most large herbivore species' populations declining following the 1992 drought and increasing thereafter. Therefore, droughts are important in influencing large herbivore populations in semi-arid ecosystems. Furthermore, the results showed variation in the intensity of illegal hunting (top-down human control) which was associated with variation in law enforcement efforts in Gonarezhou. Law enforcement efforts in Gonarezhou were strengthened in 2004 following the employment of additional patrol rangers which resulted in increased park coverage and a decline in recorded illegal activities. Thus, the results show that 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 (CAMPFIRE - a community-based program that allows local people living in communal areas near protected areas in Zimbabwe to financially benefit from using the wildlife resources within their area) was partly associated with a decline in human-wildlife conflicts. In addition, local communities with higher perceived effectiveness of CAMPFIRE programs partly had more favourable attitudes towards problematic wild animals. Moreover, the results showed that in the 1990s, the majority of newspaper articles highlighted that wildlife conservation in Zimbabwe was largely successful. However, following the land reforms that occurred in 2000, the international media lost interest in wildlife conservation in Zimbabwe, as evidenced by a sharp decline in published articles. Also, the frames changed in the international media with the "political unrest and land reform" blame frame becoming more dominant, and nature conservation was portrayed more negatively. The change in media frames shows that there was a spill-over effect from the political domain into wildlife conservation following Zimbabwe's land reforms in 2000.

Overall, this study provides new insights on the processes influencing large herbivore population dynamics in human-dominated semi-arid savanna ecosystems which consist of diverse wildlife management regimes and also illuminates the importance of media framing and (mis-)representation of wildlife conservation issues following political instability, crisis or societal unrest. With these findings, 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.

Samenvatting

Behoud van wilde soorten in terrestrische ecosystemen vereist een begrip van de processen die de grootte van populaties beïnvloeden. Bottom-up en top-down processen spelen een belangrijke rol in de populatiedynamiek van grote herbivoren, maar de invloed van deze processen variëert in ruimte en tijd. Tot voor kort heeft de rol van door de mens veroorzaakte bottom-up en top-down processen echter weinig aandacht gekregen, ondanks het feit dat bijna alle terrestrische ecosystemen worden beïnvloed door menselijke activiteiten die hoogstwaarschijnlijk het natuurlijk verloop van dierpopulaties beïnvloeden. Dit proefschrift onderzoekt derhalve de rol van natuurlijke en door de mens veroorzaakte processen in het beïnvloeden van populaties grote herbivoren en hoe instrumenten - waaronder beleidsinstrumenten, stimulansen en voorzieningen - menselijke activiteiten en het behoud van de natuur in een semi-aride Afrikaanse savanne ecosysteem beïnvloeden. Dit onderzoek richt zich vooral op Gonarezhou National Park (hierna: Gonarezhou), Zimbabwe en aangrenzende gebieden. Zimbabwe heeft tussen 2000 en 2008 een economische crisis en politieke instabiliteit gekend na de landhervormingen die in 2000 zijn begonnen en waarover op grote schaal werd geschreven in de massamedia.

Uit het onderzoek kwam binnen hetzelfde klimaatsgebied een zwakke samenhang naar voren tussen de natuurlijke bottom-up-processen neerslag en droogte. De samenhang tussen populatiefluctuaties van grote herbivoren soorten en droogte bleek variabel, waarbij de ernstige droogte in 1992 over het algemeen leidde tot een afname van de meeste grote herbivorensoorten, en een herstel in de periode daarna. Droogte speelt blijkbaar een belangrijke rol in het beïnvloeden van herbivorenpopulaties in semi-aride ecosystemen. De resultaten lieten ook fluctuaties zien in de intensiteit van de illegale jacht (een top-down menselijke invloed); die fluctuaties bleken geassocieerd met variatie in de wetshandhaving in Gonarezhou. Wetshandhaving in Gonarezhou werd versterkt in 2004 door het aanstellen van

extra parkwachters die patrouilles uitvoerden. Daarmee werd een groter deel van het park bereikt, met een daling van het aantal geregistreerde illegale activiteiten tot gevolg. De resultaten laten derhalve zien dat politieke instabiliteit en economische crisis niet noodzakelijkerwijs leiden tot een verhoogde illegale jacht wanneer beleidsinstrumenten, zoals wetten, worden afgedwongen.

Uit het onderzoek bleek tevens dat er een samenhang is tussen enerzijds de mate waarin men het Communal Areas Management Programma For Indigenous REsources (CAMPFIRE - een natuurbeheersprogramma waarbij de lokale bevolking uit de zogenoemde "communal areas" in de buurt van de nationale parken in Zimbabwe delen in de inkomsten uit commerciële exploitatie van wild) als effectief ervaart, en anderzijds het ervaren niveau van conflict tussen mensen en wilde dieren (hoe hoger de effectiviteit, hoe minder conflict). Bovendien, hadden lokale gemeenschappen die de effectiviteit van het CAMPFIRE programma hoger inschatten, ook een meer positieve houding ten aanzien van problematische wilde dieren. De onderzoeksresultaten lieten voorts zien dat in de jaren 90 het grootste deel van de krantenartikelen benadrukte dat natuurbehoud in Zimbabwe behoorlijk succesvol was. Dat veranderde echter na de landhervormingen die plaatsvonden na 2000. De internationale media verloren hun interesse voor natuurbehoud in Zimbabwe, zoals blijkt uit een scherpe daling van het aantal daarover gepubliceerde artikelen. Tevens veranderden toen ook de media frames in de internationale media: het "politieke onrust en landhervorming" media frame werd steeds dominanter en over het natuurbeheer werd negatief bericht. Die verandering in de media frames geeft aan dat er sprake was van een zogenaamd "spill-over effect" van de politieke problemen volgend op de landhervormingen in Zimbabwe, naar het natuurbeheer.

Deze studie geeft nieuwe inzichten in de processen die de dynamiek van populaties van grote herbivoren beïnvloeden in door de mens gedomineerde semi-aride savanne

ecosystemen. Deze bestaan uit diverse wildbeheer regimes en benadrukken ook het belang van media framing en (mis-)representatie van natuurbeheersproblemen na politieke instabiliteit, crisis of maatschappelijke onrust. Op basis van deze bevindingen wordt geconcludeerd dat natuurlijke processen (bijv. droogte) de populatiedynamiek van grote herbivoren bottom-up beïnvloeden, terwijl beleidsinstrumenten, stimulansen, voorzieningen en maatschappelijke kaders vooral een top-down invloed hebben op de wilde populaties van grote herbivoren in savanne ecosystemen.

Pfupikiso

Kuchengetedzwa kwemhuka dzesango munharaunda madziri kunoda kuti pave nokunzwisiswa kwezvinoderedza kana kuwedzera uwandu hwadzo. Zvinoderedza kana kuwedzera izvi zvinokosha pakuchinja kunoita uwandu hwemhuka huru dzinodya zvinomera, nepowo simba rezvinoderedza kana kuwedzera izvi richisiyana-siyana mukuenderana nenzvimbo kana nguva. Zvisinei, kusvikira nguva pfupi yapfuura, maitiro evanhu ayo anoguma nokuwedzera kana kuderera kwouwandu hwemhuka ave asiri kunyatsoongororwa. Izvi zvakadaro pasinei nokuti mararamiro emhuka munzvimbo dzose zvadzo ane zvaanoitwa nemaitiro evanhu ayo anoguma nokuchinjwa kwezvagara zvirizvo zvinochinja uwandu hwemhuka. Naizvozvo, muino tsvakurudzo itsva, migumisiro yezvagara zvichiitika uye zvinoitwa nevanhu, izvo zvinoguma nokuchinja kwouwandu hwemhuka huru dzinodya zvinomera, pamwewo nokuti urongwa hwevanhu (seizvi, magwaro omutemo, mibayiro nezvipo) hune zvahunoita pamaitiro evanhu uye pakuchengetedzwa kwemhuka munzvimbo dzemhuka idzo dzisinganayi mvura yakawanda dzomuAfrica, zvinoongororwa. Ongororo ino inonyanya kutarisa nzvimbo inochengeterwa mhuka yeGonarezhou National Park (iyo ichange ichidaidzwa kunzi Gonarezhou), Zimbabwe nenzvimbo dziri pedyo nayo. Zimbabwe yakapindana nematambudziko ezvoupfumi uye kusagadzikana kwezvematongerwo enyika mumakore ari pakati pa2000 na2008 pashure pezvirongwa zvokugova ivhu patsva zvakatanga muna 2000 izvo zvakabudiswa zvakanyanya mumapepa nhau nedzimwe mhando dzakasiyana-siyana dzekushambadzira.

Zvakabuda pakuongorora uku zvakaratidza kusiyana kukuru mune zvokunaya uye kusanaya kwemvura (kuwedzera kwagara kuchingoitika kwouwandu hwemhuka) munzvimbo dziri mumamiriro okunze akafanana, nemaitiro akasiyana-siyana aiitwa nemhuka huru dzinodya zvinomera, zvichibva pakusanaya kukuru kwemvura kwa1992, zvichiguma nouwandu hukuru hwemhuka huru dzinodya zvinomera huchiderera pashure pokusanaya

kwemvura kwa1992, dzokonokei howedzera pashure pacho. Nokudaro, kusanaya kwemvura kune zvakunoita pauhwandu hwemhuka huru dzinodya zvinomera, dziri munzvimbo dzemhuka dzisinganayi mvura yakawanda. Kuwedzera kune izvi, zvakabuda paongororo iyi zvakaratidzawo kusiyana-siyana maererano nokuvhima mhuka kusiri pamutemo (kudzikira kwouwandu hwemhuka zvichiparirwa nevanhu) izvo zvakaparirwa nokusiyana-siyana kwezvaiitwa muGonarezhou, kana totaura nenzira dzokuona kuti mutemo wachengetedzwa. Kuchengetedzwa kwomutemo kwakasimbiswa muGonarezhou muna 2004 mushure mokuwedzerwa kwevanoita basa rokutenderera vachichengetedza mhuka, izvo zvakaguma nokutarisirwa kwakawedzerwa kwenzvimbo inochengeterwa mhuka uyewo kudzikira kwokuparwa kwemabasa ari kunze kwomurau. Nokudaro, zvakabuda pakuongorora zvinoratidza kuti kusagadzikana mune zvematongerwo enyika uye kuparara kwezvoupfumi hakusi iko kunonyanya kuparira kuvhimwa kwemhuka zviri kunze kwomutemo, kana kuri kuti magwaro omutemo, ari kunyatsoshandiswa.

Kunyatsoshanda zvakanaka kwe*Communal Areas Management Programme for Indigenous Resources* (CAMPFIRE – chirongwa chenharaunda chinogonesa vanhu vomunharaunda dzomumaruwa ari pedyo nenzvimbo dzinochengetedzwa dzomuZimbabwe kubatsirikana mune zvemari zvichibva pakushandiswa kwezvinowanikwa kubva mumhuka dzinochengetwa munharaunda yavari) kwakavawo nezvakunoita pakudzikira kwemakakatanwa panyaya dzevanhu nemhuka. Kuwedzera kune izvi, vanhu vomunharaunda dzine zvirongwa zveCAMPFIRE zvinonyatsoshanda zvakanaka, vaivawo nemaonero ari nane kana toreva nezvemhuka dzomusango dzinenge dzava kuparira matambudziko. Kuwedzerawo zvakare, zvakabuda muongororo iyi zvakaratidza kuti muma 1990, nyaya dzakawanda dzomumapepanhau dzakabudisa pachena kuti kuchengetedzwa kwemhuka dzomusango muZimbabwe kwaiva kuchibudirira zvikuru. Zvisinei, zvichitevera zvirongwa zvokugova ivhu patsva izvo zvakaitika muna 2000, vanobudisa nhau dzepasi pose vakapera mwoyo

nezvenyaya yokuchengetedzwa kwemhuka muZimbabwe, sezvakaratidzwa nokuderera kukuru kwenyaya dzavaibudisa, uyewo mafungiro akachinja muvanobudisa nhau dzepasi pose sezvo vakanga zvino vati nangananga nepomero dzo"kusagadzikana kwezvematongerwo enyika uye kugovewa patsva kwevhu." Kuchinja kwemafungiro evanobudisa nhau kwakaoneka kuti kwakanga kwayambukira kunyaya yokuchengetedzwa kwemhuka kuchibva kunyaya dzezvematongerwo enyika, zvichitevera zvirongwa zvokugoverwa patsva kwevhu muZimbabwe muna 2000.

Tichitarisa zvose hazvo, ongororo iyi inopa maonero matsva nezvemaitiro ane zvaanoita pakuchinja kwouwandu hwemhuka huru dzinodya zvinomera idzo dziri munzvimbo dzinotarisirwa nevanhu, dzisinganaye mvura yakawanda, uye dzine zvirongwa zvakasiyana-siyana zvokutarisirwa kwemhuka, uyewo ongororo yacho inonyatsoratidza kukosha kwemaonero evanobudisa nhau pamwe nokumiririra kana kusamiririra zvakanaka nyaya dzokuchengetedzwa kwemhuka zvichitevera kusagadzikana kwezvematongerwo enyika, kuoma kwezvinhu kana kuti kusagadzikana kwevanhu. Neizvi zvakawanika pakuongorora, mhedziso ndeyokuti zvinodzora izvo zvagara zviripo (somuenzaniso, kusanaya kwemvura) zvine zvazvinoita pauwandu hwemhuka huru dzinodya zvinomera nepowo zvakare magwaro emitemo, mibayiro, zvipo uye mafungiro omunharaunda zvine zvazvinoita pamaitiro evanhu ayo ane zvaanoita pauwandu hwemhuka dzesango dziri munzvimbo dzisinganayi mvura yakawanda.

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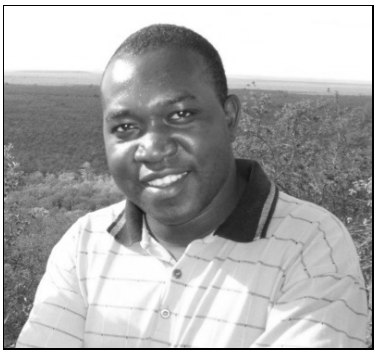
Curriculum Vitae



Edson Gandiwa was born on the 8th of August 1980 in Lomagundi, Zimbabwe. He attended Primary School at Mhangura Mine (Mhangura); Secondary School at Kuwadzana (Banket) and High School at Waddilove (Marondera). He graduated from the National University of Science and Technology, Zimbabwe, with a BSc (Hons) in Environmental Science and Health (*with first class*) in 2004. In his BSc thesis, supervised by Clifford Tafangenyasha and Geoffreys Matipano, he studied the effects of repeated burning on savanna woody vegetation. After completing his BSc studies he joined the Zimbabwe Parks and Wildlife Management Authority in October 2004 as an ecologist based in Gonarezhou National Park. In August 2005, he commenced his MSc studies at the University of Zimbabwe and obtained an MSc degree in Tropical Resource Ecology (*with merit*) in 2007. In his MSc thesis, supervised by Shakkie Kativu, he studied the influence of fire frequency on semi-arid savanna woodlands in Gonarezhou National Park. In June 2008, he started his PhD research at Wageningen University, The Netherlands, at the Resource Ecology Group and the then Communication and Innovation Studies Group now Knowledge, Technology and Innovation Group. His PhD research was part of the Competing Claims on Natural Resources Programme. He was primarily supervised by Herbert Prins, Cees Leeuwis and Ignas Heitkönig. His research focussed on the natural and human-induced top-down and bottom-up controls on wild large herbivore numbers in the semi-arid savanna ecosystem of Gonarezhou National Park and adjacent areas. His research also included an analysis of media framing of wildlife conservation in Zimbabwe. He was appointed an Associate Professor in the Department of Wildlife and Safari Management at Chinhoyi University of Technology, Zimbabwe in April 2013. His current research interests include: bushmeat hunting and trade dynamics, community-based natural resources management, media framing, plant ecology, population ecology and wildlife conservation.

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PE&RC PhD Education Certificate

With the educational activities listed below the PhD candidate has complied with the educational requirements set by the C.T. de Wit Graduate School for Production Ecology and Resource Conservation (PE&RC) which comprises of a minimum total of 32 ECTS (= 22 weeks of activities)

Review of literature (5.6 ECTS)

- Human effects on multi-species wildlife population abundances (2008)

Writing of project proposal (4.5 ECTS)

- Human effects on multi-species wildlife population abundances in tropical savannah areas (2008)

Post-graduate courses (5.8 ECTS)

- Analysing farming systems and rural livelihoods in a developing world; Wageningen University / University of Zimbabwe (2008)
- The art of modelling; PE&RC (2010)

Invited review of (unpublished) journal manuscript (2 ECTS)

- African Journal of Ecology: vegetation structure and composition in protected versus unprotected areas (2012)
- Pachyderm: elephant effects on woodlands (2012)
- Tropical Conservation Science: bushmeat hunting and consumption in tropical savannahs (2012)
- African Journal of Range and Forage Science: rangeland degradation in an African savannah (2012)
- Journal for Nature Conservation: perceptions of large carnivore hunting in Europe (2013)

Deficiency, refresh, brush-up courses (3 ECTS)

- Introduction to communication and innovation studies (2008)
- Research design and research methods (2008)
- Models for forest and nature conservation (2008)

Competence strengthening / skills courses (2.5 ECTS)

- Design, analysis and reporting of aerial surveys of large herbivores; Monitoring of Illegal Killing of Elephants (MIKE), South Africa (2009)
- Information literacy for PhD including EndNote introduction; WUR (2011)
- Scientific publishing: WGS (2011)
- Reviewing a scientific paper; WGS (2011)

PE&RC Annual meetings, seminars and the PE&RC weekend (1.8 ECTS)

- PE&RC Introductory weekend (2008)
- PE&RC Day (2008)
- PE&RC Weekend for last years (2012)

Discussion groups / local seminars / other scientific meetings (6.9 ECTS)

- Competing Claims on Natural Resources Seminar; Acornhoek, South Africa (2007)
- Transfrontier Conservation and Veterinary Quarterly meetings; Zimbabwe (2009)
- Competing Claims on Natural Resources Book Write Seminar 'Living on the Edge'; Mabalauta, Chiredzi, Zimbabwe (2009)
- Annual Ecologist Meeting; Zimbabwe Parks and Wildlife Management Authority, Zimbabwe (2009)
- Competing Claims on Natural Resources Seminar; Mushumbi Pools, Zambezi Valley, Zimbabwe (2010)
- Ecological Theory and Application Discussion Group; WUR (2008, 2012)

International symposia, workshops and conferences (7.3 ECTS)

- 9th African Wildlife Consultative Forum; Victoria Falls, Zimbabwe (2010)
- 10th Animal and Human Health for the Environment and Development-Great Limpopo transfrontier Conservation Area (AHEAD-GLTFCA) Workshop; Hazyview, Mpumalanga, South Africa (2010)
- Seminar on Forest Law Enforcement and Governance for Developing Countries; State Academy of Forest Administration; Beijing, China (2010)
- Interdisciplinary research and Education Fund (INREF) Conference; Wageningen, the Netherlands (2012)

Lecturing / supervision of practical's/ tutorials; (3 ECTS)

- Wildlife ecology; MSc course, Tropical Resource Ecology Programme, University of Zimbabwe (2009)
- Plant ecology; MSc course, Tropical Resource Ecology Programme, University of Zimbabwe (2010)

Supervision of MSc student (3 ECTS)

- Media representation of wildlife conservation in Zimbabwe

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