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Research Article

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ABSTRACT

This study aimed at assessing the patterns of vegetation fires and their impact in Nyanga National Park (NNP), Zimbabwe. Field assessments were conducted in September 2012. Our results showed that fires are common in NNP with the majority of fires being caused by poaching activities. Moreover, anthropogenic activities, particularly agricultural activities, in the boundaries of the park also increased the fire occurrences. However, there were no significant increases in number of fires or spatial extent of burnt area between 2008 and 2012 ($P > 0.05$). Fires influenced vegetation structure and composition, wildlife communities and negatively affected infrastructure within the park. We recommend for the development of a fire management plan for NNP.

Keywords: Afromontane forests, habitat, wildfires, wildlife.

INTRODUCTION

Fires are a common phenomenon across the African continent (Frost and Robertson, 1987; Bond et al., 2005; Archibald et al., 2012). The Afromontane forests are vulnerable to fires with wildfires mainly interfering with regeneration, as it wipes out seedlings and saplings which cannot withstand the damage (Jimu, 2011). Fire has been an agent of disturbance for thousands of years (Bond, 2008). Wildfires have occurred long before the advent of humans, shaping landscape structure, pattern and ultimately the species composition of ecosystems (e.g., Frost and Robertson, 1987). Although some fires are the result of natural causes such as lightning, most fires are lit by man (Gandiwa and Kativu, 2009). Repeated fires affect many ecological processes, such as nutrient cycling, soil organic matter content, the cover of trees versus grasses, and the quality and structure of the grass sward (Gandiwa, 2011a). Regular burning also has significant ecological effects on the herbivores living in the affected ecosystems (Klop and van Goethem, 2008).

Uncontrolled or unplanned fires can cause adverse impact on the environment and human society (Moe et al., 1990; Bond and Keeley, 2005; Eriksen, 2007). The majority of impact of uncontrolled, human-induced fires on ecosystems is generally negative. Therefore, as a result of the impact of large-scale forest/woodland fires in the 1980s and early 1990s globally, the issue has been forced onto the international agenda. Under Agenda 21 of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil, fires were mentioned as one of the many threats to ecosystems (Robinson, 2001; Secretariat of the Convention on Biological Diversity, 2001).

Zimbabwe has recorded an increase in fires over the past decade and protected areas have not been spared by these fires (Tafangenyasha, 2001; Mapaure and Campbell, 2002; Gandiwa and Kativu, 2009; Nyamadzawo et al., 2013). Some of the general anthropogenic factors influencing the increase in fire frequency include illegal hunting, land clearing for agricultural purposes, arsonist motives , unattended or out - of - control

campfires and discarded burning cigarettes. About 15% of Zimbabwe is covered by protected areas which are also affected by wildfires (Government of Zimbabwe, 2010). One such protected area is the Nyanga National Park (hereafter NNP). Therefore, the objectives of this assessment were: (1) to document fire occurrences; (2) determine their effects in NNP, and (3) suggest appropriate action for managing fires in the protected area.

METHODS AND MATERIALS

Study area

Nyanga National Park (NNP) was established in 1926 and is located in the eastern highlands of Zimbabwe (Fig. 1; Nzengy'a, 2004). The park covers an area of approximately 47,000 hectares with varying landscapes encompassing mountains and rivers with stunning waterfalls and gorges. The altitude of the park ranges from 700m in the Pungwe valley to 2,592 m on Mt Nyangani (ZPWMA, 2011). NNP has a cool and wet climate with an annual rainfall of between 1,500 and 3,500mm. Mean annual temperatures range from a minimum of 9 to 12°C to a maximum of 25 to 28°C. The park is characterised by scenic grassland areas interspersed with fynbos-like vegetation on the plateau summit, unique dwarf *Brachystegia spiciformis* woodland, moist montane forest and patches of medium to low altitude rainforest in the Honde and Pungwe valleys (Fig. 2).

Figure 1: Location of Nyanga National Park (red box) in eastern Zimbabwe. Source: Nzengy'a (2004).

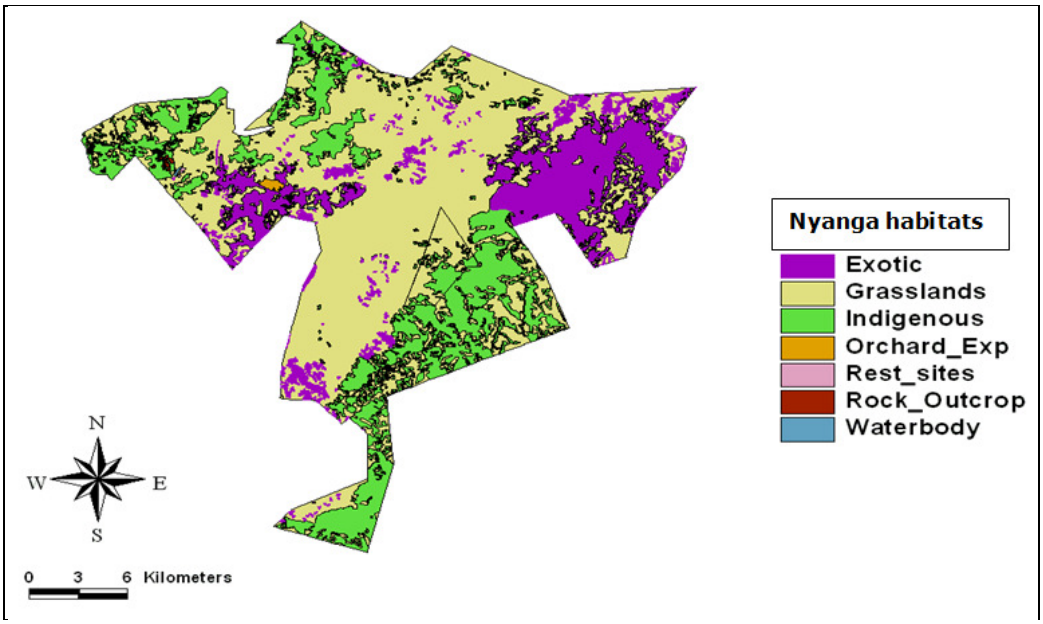

Figure 2: Habitats in Nyanga National Park, Zimbabwe. Source: ZPWMA (2011).

NNP contains the largest undisturbed area of montane grasslands in Zimbabwe and a large proportion of the montane forests, particularly on Nyangani Mountain. The high humidity and low evaporation rates provide good conditions for continuous plant growth throughout the year (Gandiwa and Gandiwa, 2012). The fauna of NNP is not extensive, but does contain several endemic species of reptiles. The blue duiker (*Cephalophus monticola*), Samango monkey (*Cercopithecus albogularis*) and Gurney's sugarbird (*Promerops gurneyi*) are among the protected species found in this park. Small wildlife populations of a few large mammal species exist at NNP, namely the blue wildebeest (*Connochaetes taurinus*), waterbuck (*Kobus ellipsiprymnus*), greater kudu (*Tragelaphus strepsiceros*) and plains zebra (*Equus quagga*) that were introduced into the NNP since the park formation, and their populations are still small. Historical data from NNP give insights to the fact that fires are a common phenomenon in the park (Fig. 3). Extensive grass fires occur in the high-elevation grasslands from August to November (ZPWMA, 2011; Jimu et al., 2013).

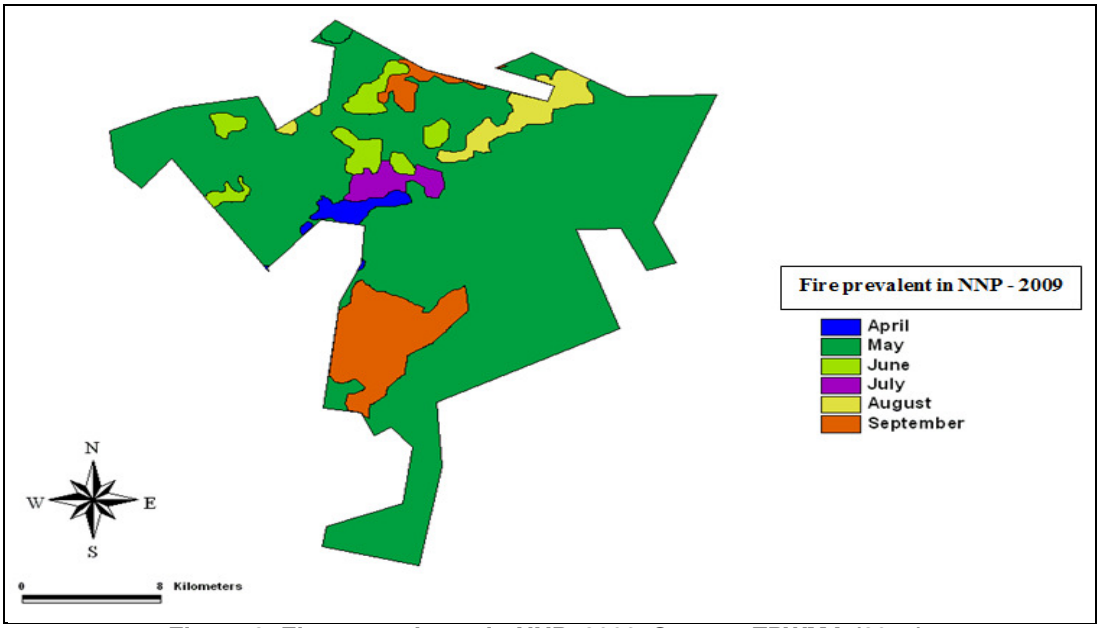

Figure 3: Fires prevalence in NNP, 2009. Source: ZPWMA (2011).

Data collection and analyses

Field assessments were conducted in September 2012 and areas that were most burnt were visited for visual assessments. A total of 47km was traversed following major roads in the park across various habitats and visual observations of fire impacts on vegetation were noted. The General Management Plan for NNP was used for park familiarization whereas field guides helped in identifying the plants and animals. Moreover, additional data on the nature of fires (i.e., areas affected with fires within the park, trends, season of burn, causes of fire) and their impacts (negative and positive) were collected from the park fire records and also through discussions with the aid of face-to-face interviews with three park management staff. Data were analysed through qualitative and quantitative approaches in order to show the spatial extent of fires in the park, causes of fires, trends of fire occurrences through simple linear regression, and impact of fires on the ecosystem.

FINDINGS AND DISCUSSION

Trend and spatial occurrence of fires

Figure 4 shows the trend number of fires recorded in NNP between 2008 and 2012. The number of fires per year in NNP did not increase or decrease between 2008 and 2012 ($F_{1,3}$ = 2.29, P = 0.227). Similarly, the annual burnt area in NNP, did not increase or decrease between 2008 and 2012 ($F_{1,3}$ = 1.16, P = 0.361) (Fig. 5).

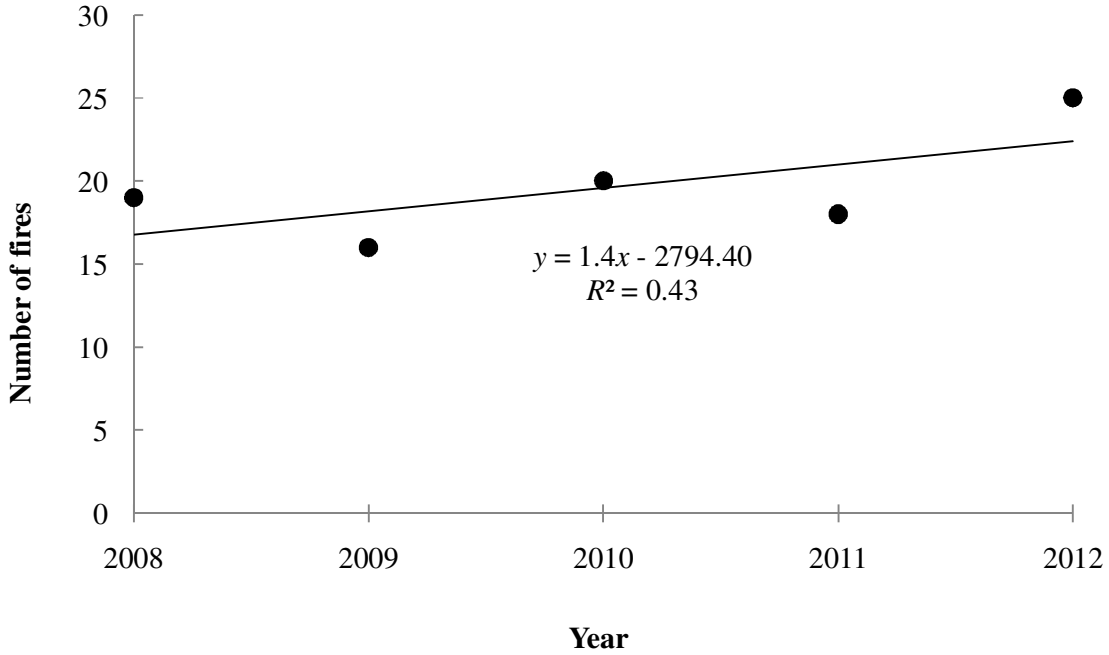

Figure 4: Trend in the number of fires recorded in Nyanga National Park between 2008 and 2012. Source: Nyanga National Park Fire Records.

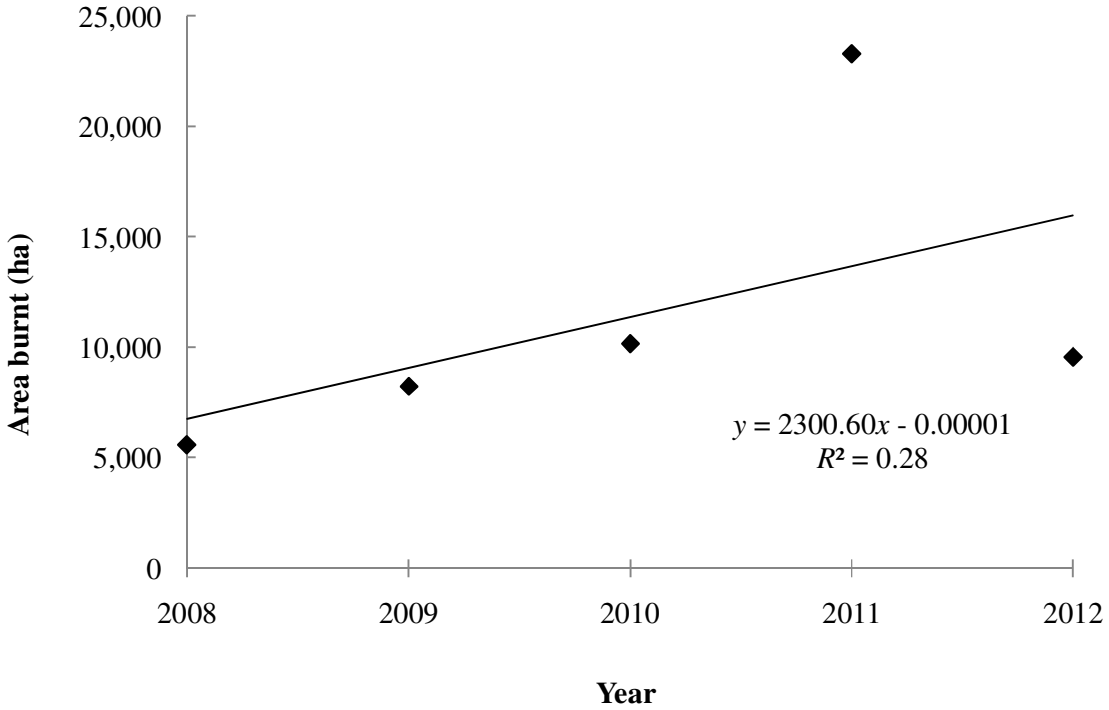

Figure 5: Trend in annual area burnt in Nyanga National Park from 2008 to 2012. Source: Nyanga National Park Fire Records.

Areas where fires are common in NNP are given in Table 1 together with causes and other attribute data. As for the year 2012, in September, about 20% of NNP was reportedly burnt with about 1.5% attributed to controlled fires. Most of the fires were reportedly started in the west and east of NNP. These sections border communal areas, hence, the high fire incidences since fires are used for land preparations in these communities.

Table 1: Spatial extent and causes of fires in Nyanga National Park

Area	Causes	Attribute	Remarks
Dazi	Land preparation and bee hives	No firebreaks	Much of grassland area in the park
North-western part of Nyanga (Warrendale)	Land preparation and poachers	–	–
Nyazengu	Poachers	–	Fires that start in this area usually burn large areas
Chikorokoto gorge	Fires start from eastern highlands area	–	–
Circular drive and public roads	Visitors and road users	–	–
Nyarerwe (close to Nyanga village)	Garbage burning	–	–

Note: – denotes not applicable. Source: Nyanga National Park Fire Records and Park management.

Causes of fires

The contribution of natural fires such as those caused by lightning is very small (~1% in most ecosystems) in comparison to the number of fires started by humans (see Table 2 below in NNP). The vast majority of wildfires are intentionally set fires in NNP for illegal hunting or extraction of natural resources within the park. Elsewhere, in Gonarezhou National Park wildfires were also reported to be used in the illegal hunting of wildlife (Gandiwa, 2011c). Furthermore, human encroachments near protected areas have also been attributed to increase in fire occurrences in NNP, as also reported for Gonarezhou National Park, Zimbabwe (Gandiwa et al., 2011). Another cause of fires includes fires that rekindle after being put-off.

Table 2: Recorded causes of fires in Nyanga National Park, 2012

Cause	Percentage (%)
Poachers	56
Rekindled fires	16
At times fires escape from adjacent timber plantations	12
Honey mongers	6
Faulty electricity cables	6
Public road users	4

Source: Nyanga National Park Fire Records and Park management.

Impact of fires on animals and habitats

Wildfires, controlled or uncontrolled, have profound impact on the physical environment including: land cover, biodiversity, and ecosystem function (Frost and Robertson, 1987). They also have enormous implications for human health and on the socio-economic system of affected areas. Fires change biomass stocks (through tree loss) and areas experiencing high fire frequency have recorded gradual loss of trees resulting in more open areas (Figure 6) (Hanan et al., 2008). Fires can alter the hydrological cycle with knock-on effects for river systems, and in NNP this could negatively affect several water sources. Hot fires leave some areas bare and devoid of cover resulting in accelerated runoff, soil erosion and consequently this compromises the quality and quantity of water in the ecosystem (Smit et al., 2012).

Figure 6: Effects of fires on habitats and wildlife in NNP. Photo credits: P. Zisadza-Gandiwa.

Some of the direct effects of fire on ecosystems fauna is absolute death, smaller mammalian species and reptiles are burnt to death (Quinn, 1994), however others are wounded and die later due to injuries sustained during fire occurrence in their habitat. In NNP, some animals, such as baboons, bush pigs and kudu have been recorded to have died as a result of wildfires (Park management, *personal communication*). Indirect effects of fires are far reaching and longer term, and include plant stress due to water loss, and loss of habitat or territories (Neary et al., 1999; Sheuyange et al., 2005). Fires can also cause the displacement of animals, which may influence the ecosystem processes and functions and animal distribution patterns at both local and regional scales (Gandiwa, 2013a, b). Ecosystem balance is also affected and ultimately results in the loss of biodiversity and dispersal mechanisms of wide ranging species are also affected. Loss of forage reduces the ecological carrying capacity of the protected area, causing overall decline in species that rely on fruits for food (Moe et al., 1990). The destruction of standing cavity trees as well as dead logs on the ground affects most small mammal species and cavity-nesting birds (Utete and Mwedzi, 2012).

Wildfires in NNP, if not controlled effectively, pose a serious threat to wildlife and its diverse habitats. Some species are affected by the heat and smoke of fires; some subsequently die from the lack of food and water, also habitat degradation and loss of it. Small slow-moving animals are the highest risk of being engulfed in flames and smoke. Other species that are highly selective in their habitat requirements are affected, their sensitivity to changes in specific food, habitat or climate requirements make them vulnerable and more at risk and may be decimated by effects of wild fires especially if they cannot find alternative suitable habitat. Fire can destroy critical wildlife habitat and alters the biodiversity components of remaining habitat areas. Fleeing animals

can be killed in surrounding areas (depending on land use) in search of food and water in case of communal areas.

One of the most important ecological effects of burning is the increased probability of further burning in subsequent years, as dead trees topple to the ground, opening up the habitats to drying by sunlight, and building up the fuel load with an increase in fire-prone species. Other negative impacts can include promotion of invasive species, loss of soil nutrients, and changes in species composition particularly of plants (Brooks et al., 2004; Smith et al., 2013).

In some habitats, fire is deliberately used as a management tool through prescribed burning to maintain ecosystems in NNP, allow regeneration and clear debris. It promotes 'green pick' favoured by wildlife, regeneration of food plants, and creates habitat for various native reptiles, mammals and birds (Fig. 7). Fires have been used to improve the palatability and nutritive value of browse and grazing; to attract animals to ungrazed areas, and hence, help in grazing distribution, thus enhancing wildlife viewing opportunities (Gandiwa, 2011a); to control pests and parasites infestation and disease vectors; to reduce fire hazard or accidental fires and to minimize bush encroachment (Frost and Robertson, 1987).

Figure 7: Green lush following fires in Nyanga National Park. Photo credits: P. Zisadza-Gandiwa.

CONCLUSION AND RECOMMENDATIONS

We conclude that fires are a common phenomenon in NNP although we did recorded no significant increases in number of fires or spatial extent of burnt area between 2008 and 2012. Most of the fires in NNP were started by humans with areas near the park boundary with communal areas frequently burning. Moreover, fires influenced vegetation structure and composition, and wildlife communities in NNP. Given the importance of fire as a key driver in NNP ecosystem, informed fire management is essential for effective biodiversity management. Therefore, the identification and development of appropriate fire management regimes for NNP should be prioritized. We recommend the following: (i) recognizing local communities and stakeholder activities in the conservation of wildlife in NNP. This will allow for the development of fire management plans which are accommodative of surrounding environments, and adaptable to changing environments; (ii) the need for outreach and education to local communities on wildlife and fire management; and (iii) there is need for ZPWMA to make efforts to address the ranger staffing levels in NNP as appropriate law enforcement staff will assist in anti-poaching patrols, early fire occurrence detection and firefighting.

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