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Effects of Prescribed Burning on Abundance of Common Herbivores in Matekenya Vlei, Sengwa Wildlife Research Area (SWRA), Zimbabwe

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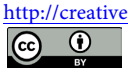

Abstract

Fire is commonly used to remove long, dry, low-nutritious grass and generate fresh grass for wildlife. The study sought to examine the impact of prescribed burning on common herbivore abundance and habitat selection in Matekenya Vlei, Sengwa Wildlife Research Area (SWRA). Four-line transects, two in each block (burnt and unburnt) were set. The average length of each transect was 2.5 km. Daytime transect surveys were conducted between 07:00 hours and 08:00 hours morning and 16:00 hours and 17:00 hours afternoon. Two observers walked along transect lines on the 6th and 7th September 2020 recording all sightings at first sight. Comparison of individual species group size between burnt and unburnt blocks and between morning and afternoon were done using parametric paired-t-test and nonparametric Mann-Whitney U-test respectively. A total of eleven common herbivore species (n = 11) were recorded in all blocks. There was no significant difference in group size of impala (*Aepyceros melampus*), zebra (*Equus burchelli*), and warthog (*Phacochoerus aethiopicus*) except for waterbuck (*Kobus ellipsiprymnus*) ($p < 0.005$) between burnt and non-burnt blocks. Waterbuck (*Kobus ellipsiprymnus*), zebra (*Equus burchelli*), reedbuck (*Redunca arundinum*), impala (*Aepyceros melampus*) and warthog (*Phacochoerus aethiopicus*) preferred burnt areas. Buffalo (*Syncerus caffer*) and elephant (*Loxodonta africana*) were predominantly found in tall unburnt areas. Sightings between morning and afternoon varied with species. Researches to establish how management fires can be used to influence herbivore abundance over a long period after prescribed burning are recommended.

Subject Areas

Rangeland and Wildlife Management

Keywords

Common Herbivores, Matekenya Vlei, Prescribed Burning, Vegetation, Habitat, Riverine and Interaction

1. Introduction

Prescribed burning is the process of planning and applying fire to a predetermined area, under specific environmental conditions, to achieve the desired outcome (Moyo, 2013) [1]. Fire is an important process in the ecology of most native plant and animal communities. Prescribed burning is used as a common strategy for clearing long, dry, low-nutritious grass and generating fresh grass for purpose of creating fresh forage for herbivores (Wagner, 2008) [2]. It can also be used as a hazard reduction strategy to mitigate against potential hot fires (Gambiza *et al.*, 2009) [3].

Fire can be natural or a result of human activities through arson and/or prescribed burning. Human activities may include burning in preparation for grazing animals and to reduce accumulation of moribund materials or illegal fires started by poachers aimed to drive animals to open areas (Stephanie *et al.*, 2014) [4]. The effect of fire on a plant community largely depends on the type of fire and season (Mapiye *et al.*, 2008) [5] as well as on the characteristics of the plant community itself. Some fires are destructive whilst others are helpful to the ecosystem. The degree of damage to trees and shrubs depends on fire frequency, season or time of burn, species involved and the type of burn (Mapiye *et al.*, 2008) [5].

Total exclusion of fires can impoverish biological diversity because there may be no external forces to check species that have a tendency to grow vigorously and multiply, chocking out others (Fuhlendorf *et al.*, 2004) [6]. Prescribed fire is important in savanna ecosystems to help in promoting structural and spatial heterogeneity which in turn supports higher diversity. Prescribed fires are known to influence large mammalian herbivore communities. Stephanie *et al.* (2014) [4] indicated that post-fire stimulation of plant nutrients is thought to benefit grazing mammals and explains their preference for burnt areas. However, fire also reduces vegetation height and increases visibility, thereby potentially reducing predation risk. Consequently, fire may be more beneficial to smaller herbivores, with higher nutritional needs and greater risks of predation. Different herbivore species have different nutritional demands, hence, fires may change the composition of the herbivore community (Wagner, 2008) [2] through their effects on the structure and composition of the habitat. The animals' foraging behaviour and habitat choice are altered by fire management, both as a result of changes in available forage and as an adaptation to predators' avoidance (Brashares & Arcese, 2002) [7].

Guy (1989) [8] reviewed the influence of fire on *Brachystegia-Julbernadia* wood-

lands on the peripheries of SWRA. Management fires were extensively used in SWRA, mainly for peripheral burning to control fires originating from surrounding communal lands. Such fires would normally occur during the late dry season and are very damaging on *Brachystegia-Julbernadia* woodlands and other habitats, hence the strategy of peripheral burning. There was limited use of block burning for experimental purposes in the area, even before 1979 (Mapaure & Campbell, 2002) [9]. Gambiza *et al.* (2009) [3] recommended a combination of peripheral burning with low-intensity prescribed burning of selected blocks to keep a balance of natural fire regimes and promote biodiversity while reducing the fire hazard. Such a strategy would also provide new grass growth for herbivores in selected burnt blocks.

In SWRA, studies had been done on the interaction between vegetation and large herbivores. However, the impacts of controlled burning have received less attention yet every year, controlled burning is practiced to prevent late-season veld fires. The influence of prescribed burning on habitat selection by common herbivores in SWRA has not been scientifically investigated, despite sightings having been recorded after burning. The study sought to: 1) Compare species abundance and density of common herbivores between burnt and unburnt blocks in Matekenya Vlei, and 2) Compare individual species abundance between morning and afternoon in burnt and unburnt bocks in Matekenya Vlei.

2. Materials and Methods

Study site

The study was conducted in the Matekenya Vlei area of the Sengwa Wildlife Research Area (SWRA), north-western Zimbabwe. SWRA is 373 km^2 in size. The Matekenya Vlei is approximately 7.5 km^2 in extent and is situated at the northern part of the SWRA along the Sengwa River. It lies between 28˚25' and 28˚25' east and 18˚01' and 18˚13' south latitudes (Tafangenyasha, 2000) [10] (**Figure 1**).

Matekenya Vlei has the lowest point in SWRA at 804 m and topography is flat throughout. Indefinite recent alluvium with layered profiles derived from recent alluvium occurs in the floodplains of the Vlei. The soils are clearly depositional with abrupt textural transitions. Old alluvium, deep soils with variable colours occur on the highest terrace levels above the present day floodplains. The area is generally hot and dry with a single rainy season extending from November to April. SWRA experiences three climatic seasons: a hot wet period from November to April, a cool dry period from May to July and a hot dry period from August to October. Mean annual rainfall is 612.4 mm while mean annual temperature is 24˚C. October is the hottest month and July is the coldest (Mapaure, 2013) [11].

The main vegetation type of the area is dominated by *Terminalia sericea*. Rarer species such as *Albizia harveyi* and *Dichrostachys cineria* are represented by one or two individuals. Other vegetation types of Matekenya Vlei include a variety of *Combretum* species, *Kigelia africana*, *Croton megalobotrys*, *Faidherbia*

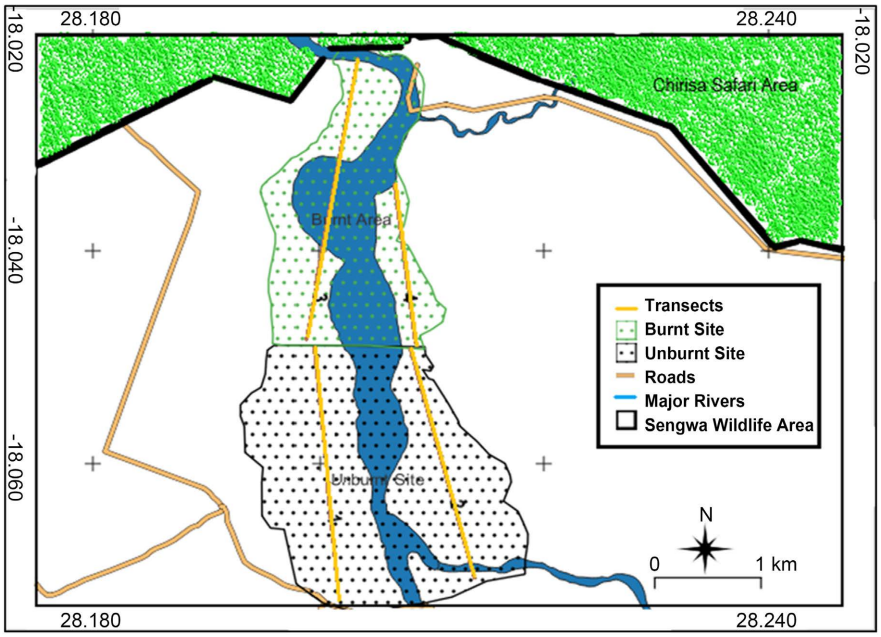

Figure 1. Location of four transects study in Matekenya Vlei of the SWRA.

albida and *Vachellia tortilis.* There is high plant species diversity in Matekenya Vlei. This may be because of regeneration by seeds that are carried from other places and deposited in the riverine by erosion forces and act of herbivores. A large part of Matekenya Vlei is dominated by open grasslands dominated by *Hyparrhenia* species and *Panicum maximum* and several forbs that are utilised by grazers.

Because of diverse habitats in the Matekenya Vlei, the site hosts an assemblage of different species of herbivores characteristic of the semi-arid woodland and grassland savannas of the Southern Africa. Overall, 18 species of herbivores have been recorded in Matekenya Vlei. Common species are zebra (*Equus burchelli*), kudu (*Tragelaphus strepsiceros*), common duiker (*Sylvicapra grimmia*), buffalo (*Syncerus caffer*), warthog (*Phacochoerus aethiopicus*), elephant (*Loxodonta africana*), impala (*Aepyceros melampus*), waterbuck (*Kobus ellipsiprymnus*), reedbuck (*Redunca arundinum*), lion (*Panthera leo*), leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta*), eland (*Taurotragus oryx*), baboon (*Papio cynocephalus*) and bushbuck (*Tragelaphus scriptus*). A total of 289 species of birds including the Secretary birds had been recorded in SWRA.

3. Data Collection & Analysis

3.1. Sampling Design and Data Collection

The study was conducted in two selected blocks of Matekenya Vlei, namely Block A (Burnt) and Block B (Unburnt). The two blocks lie adjacent to each other and separated by a graded road which was opened to facilitate burning of block A. The blocks share similar soils types, ground water and vegetation types. The vegetation at both sites is classified as tall grass prairie with small patches of

riverine woodlands.

The demarcation road to separate two sites was opened on the 9th June, 2020 using a lawn mower to prevent prescribed fires spreading into block B. Both Blocks A and B were of approximately same size 3.75 km^2. Total size of both blocks was 7.5 km^2. Controlled burning of bock A was done from the 16th to 18th of June 2020 covering the northern half of the Matekenya Vlei. Block B was left as the control site. After burning of the northern part, the area was left to flush with new shoots for three months before survey was done. No rains were received during the intervening period. In each block two fixed temporal transects were purposively selected basing on the ability of observers to identify animals from a distance using binoculars (Table 1).

On average total transect length for all blocks were 10 km, with each block averaging 5 km length. In each block, transects were demarcated from each other by the western edge of Sengwa River. Two observers walked along each transect, recording animals in the range of 500 metres perpendicular to the transect line on both sides.

Data were collected on the 6th and 7th September 2020. Daytime transect walks were done, taking care not to disturb the animals. Each line transect were surveyed once per day for two days in the morning between 07:00 hours and 08:00 hours and in the afternoon between 16:00 hours and 17:00 hours. Binoculars were used to identify animal species and classification from a distance. All animals were recorded at first sight. Observers recorded every group of species and group size.

In order to determine animal densities, four transects were scanned along on foot with transect length averaging 2.5 kilometres. Total survey effort days were two with each transect repeated twice on different days and at different time of the day. A total distance of 10 km were followed in each block, representing a penetration ratio of 1:2.6 per block (total number of kilometres walked to total survey area). Total survey area for the two blocks was 7.5 km^2.

3.2. Data Analysis

Data collected from line transects using distance sampling technique were summarized of the four transects. Each sighting observed in each survey transect was

Table 1. Transects delineated and surveyed for abundance and density of common herbivores in Matekenya Vlei, SWRA.

Block	Stratum	Transect length (km)	Line transect delineated and surveyed	Survey transect length(km)
Unburnt	Nyangondo (T.1)	2.7	1	2.7
	Manyoni Conf (T.2)	2.3	1	2.3
Burnt	Bako Pools (T.3)	3	1	3
	Mlalazi Pools (T.4)	2	1	2
Total	4	10	4	10

used as a sampling unit. Individual sightings for each species observed during transects survey in each block were treated separately. Two groups of data were produced for comparison from the two blocks using suitable statistical methods. Data for each species were also treated separately and analysed.

Group size data collected from the field for each species were first arranged before tested for normality using Kolmogorov-Smirnov normality test in MINITAB-17. Group size comparison between burnt and unburnt blocks for buffalo (*Syncerus caffer*), zebra (*Equus burchelli*), impala (*Aepyceros melampus*), reedbuck (*Redunca arundinum*), warthog (*Phacochoerus aethiopicus*), waterbuck (*Kobus ellipsiprymnus*), kudu (*Tragelaphus strepsiceros*), eland (*Taurotragus oryx*) and elephant (*Loxodonta africana*) followed a normal distribution hence, a parametric two-sample t-test were performed to test if there were significant difference on species sighting for common herbivores between burnt and unburnt blocks. Sightings on bushbuck (*Tragelaphus scriptus*) and common duiker (*Sylvicapra grimmia*) were not normally distributed and data could not be analysed using neither parametric nor non-parametric since they were single individual sightings. Group size comparison for morning and afternoon sightings for all species did not follow a normal distribution, hence, a nonparametric Mann-Whitney U-test was used to compare median for group sightings in each block.

4. Results

4.1. Common Herbivore Species Abundance and Density between Burnt and Unburnt Blocks

From the survey done, only waterbuck (*Kobus ellipsiprymnus*) showed significant difference on abundance between burnt and unburnt blocks in Matekenya Vlei ($p < 0.005$). The rest of the herbivores recorded indicated no different on group abundance between burnt and unburnt sites of Matekenya (**Table 2**).

Density of individual species varied greatly between burnt and unburnt blocks over the survey period (**Table 3**). Buffalo (*Syncerus caffer*), kudu (*Tragelaphus strepsiceros*), eland (*Taurotragus oryx*), bushbuck (*Tragelaphus scriptus*) and common duiker (*Sylvicapra grimmia*) had higher densities in the unburnt block. Bushbuck (*Tragelaphus scriptus*) and common duiker (*Sylvicapra grimmia*) did not occur at all in the burnt block. Zebra (*Equus burchelli*), impala (*Aepyceros melampus*), reedbuck (*Redunca arundinum*), warthog (*Phacochoerus aethiopicus*), waterbuck (*Kobus ellipsiprymnus*) and elephant (*Loxodonta africana*) had higher densities in burnt block.

4.2. Common Herbivore Species Abundance between Morning and Afternoon in Burnt Block of Matekenya Vlei

In burnt blocks, median abundance was higher in the morning than in the afternoon (**Table 4**). This is particularly true for waterbuck (*Kobus ellipsiprymnus*) ($p < 0.2751$), zebra (*Equus burchelli*) ($p < 0.9431$) and reedbuck (*Redunca arundinum*) ($p < 0.0343$). Warthog (*Phacochoerus aethiopicus*) abundance were

Table 2. Mean values ± SE and sample size n, for different species in burnt and unburnt blocks recorded during ground transect survey in Matekenya Vlei.

Two-sample-t-test for burnt vs unburnt										
Species	Variable	n	Mean	StDev	SE mean	Estimate for difference	95% CI for difference	T-value	P-value	DF
Zebra	burnt	13	8.23	5.78	1.6	3.23	(−1.02, 7.48)	1.58	0.129	22
	unburnt	13	5	4.6	1.3					
Impala	burnt	15	24.7	29.4	7.6	13.07	(−3.56, 29.69)	1.68	0.115	15
	unburnt	15	11.67	7.08	1.8					
Reedbuck	burnt	6	2	0.632	0.26	0.833	(−0.588, 2.254)	1.39	0.208	7
	unburnt	6	1.17	1.33	0.54					
Warthog	burnt	10	4.20	4.26	1.3	2.9	(−0.28, 6.08)	1.99	0.070	12
	unburnt	10	1.30	1.77	0.56					
Waterbuck	burnt	16	9.8	10.7	2.7	9	(3.25, 14.75)	3.33	**0.005**	15
	unburnt	16	0.75	1.61	0.40					
Kudu	burnt	5	4	4.42	2	−1.60	(−7.42, 4.22)	−0.67	0.526	6
	unburnt	5	5.6	2.97	1.3					
Eland	burnt	3	1.33	1.15	0.67	−2.67	(−6.91, 1.58)	−2.00	0.139	3
	unburnt	3	4	2	1.2					
Elephant	burnt	3	4.67	2.08	1.2	2.33	(−2.04, 6.71)	1.70	0.188	3
	unburnt	3	2.33	1.15	0.67					
Buffalo	burnt	3	4.67	8.08	4.7	−20.33	(−51.64, 10.97)	−2.07	0.131	3
	unburnt	3	25	15	8.7					

Table 3. Number of species seen in burnt and unburnt blocks and density per km^2 calculated.

Species	No. seen		Effort (Days)	Average transect length (km)		Block size (km^2)		Density (km^2)	
	Burnt	Unburnt		Burnt	Unburnt	Burnt	Unburnt	Burnt	Unburnt
Buffalo	14	75		5	5	3.75	3.75	3.73	20
Zebra	107	65		5	5	3.75	3.75	28.53	17.3
Impala	371	175		5	5	3.75	3.75	98.93	46.6
Reedbuck	12	7		5	5	3.75	3.75	3.2	1.86
Warthog	42	13		5	5	3.75	3.75	11.2	3.46
Waterbuck	156	12	2	5	5	3.75	3.75	41.6	3.2
Kudu	20	28		5	5	3.75	3.75	5.3	7.46
Elands	4	12		5	5	3.75	3.75	1.06	3.2
Elephants	12	7		5	5	3.75	3.75	3.2	1.86
Bushbuck	0	1		5	5	3.75	3.75	0	0.26
C. Duiker	0	1		5	5	3.75	3.75	0	0.26

similar in the morning and afternoon while elephant (*Loxodonta africana*) and impala (*Aepyceros melampus*) had higher abundance in the afternoon than in the morning ($p < 0.2453$ and $p < 0.3525$) respectively. Data on buffalo (*Syncerus caffer*), kudu (*Tragelaphus strepsiceros*), bushbuck (*Tragelaphus scriptus*) and Common-duiker were insufficient for Mann-Whitney U-test. Buffalo (*Syncerus caffer*) recorded no sightings in burnt area with kudu (*Tragelaphus strepsiceros*) recording two groups only in the morning. Individual sighting of common duiker and bushbuck (*Tragelaphus scriptus*) were recorded only in the afternoon.

Table 4. Species group abundance in burnt area between morning and afternoon in Matekenya Vlei.

Species	Mann-Whitney U-test for species group abundance in burnt area of Matekenya Vlei (morning and afternoon)						
	Time	n	Median	n_1-n_2	95% C.I	W	P-value
Elephant	Morning	2	1.5	−4.000	(−6999, −1.001)	3	0.2453
	Afternoon	2	5.5				
Impala	Morning	10	15	12.00	(−46.01, 62.00)	27	0.3525
	Afternoon	3	29				
Warthogs	Morning	7	3	0	(−13.002, 0.999)	20.5	0.5708
	Afternoon	4	3				
Waterbuck	Morning	4	16.5	−10.50	(−24.00, 5.00)	92.5	0.2751
	Afternoon	12	4				
Zebra	Morning	6	8	−0.50	(−7.00, 8.00)	48	0.9431
	Afternoon	7	6				
Reedbuck	Morning	5	0	2	(0.00, 3.000)	37.5	**0.0343**
	Afternoon	5	2				

Two sample t-test at $\alpha = 0.05$ in burnt and unburnt blocks for common herbivores species in Matekenya Vlei. Individual sightings for Common duiker (*Sylvicapra grimmia*) and Bushbuck (*Tragelaphus scriptus*) were not significant enough to test for mean difference between burnt and unburnt blocks using either parametric or no-parametric statistics hence was not included.

Species density was calculated as total number of animals per species sighted in each block to size of each block. Each line transect was repeated twice in two days hence total effort days is two.

Mann-Whitney U-test at $\alpha = 0.05$ median abundances between afternoon and morning in the burnt block. Only reedbuck (*Redunca arundinum*) showed significant different while the rest showed no significant different between morning and afternoon utilisation of the burnt site in Matekenya Vlei. Data on buffalo (*Syncerus caffer*), kudu (*Tragelaphus strepsiceros*), bushbuck (*Tragelaphus scriptus*) and Common-duiker were insufficient for Mann-Whitney U-test, however, buffalo (*Syncerus caffer*) recorded no sighting in burnt area with kudu (*Tragelaphus strepsiceros*) recording two groups only in the morning. Individual sighting of common duiker and bushbuck (*Tragelaphus scriptus*) were recorded only in the afternoon.

4.3. Common Herbivore Species Abundance between Morning and Afternoon in Burnt Block of Matekenya Vlei

In the unburnt block, median abundances were higher in the afternoon than in the morning for waterbuck (*Kobus ellipsiprymnus*) ($p < 0.7469$) and zebra (*Equus burchelli*) ($p < 1.00$) while abundance were higher in the morning than in the afternoon for kudu (*Tragelaphus strepsiceros*) ($p < 0.5536$), warthog (*Phacochoerus aethiopicus*) ($p < 1$), impala (*Aepyceros melampus*) ($p < 0.6232$) and elephant ($p < 1$) (Table 5). There were no differences in abundance between afternoon and morning for the rest of the animal species.

Table 5. Species group abundance in burnt area between morning and afternoon in Matekenya Vlei.

Species	Mann-Whitney U-test for group abundance in unburnt area of Matekenya Vlei (morning and afternoon).						
	Time	n	Median	n_1-n_2	95% C.I	W	P-value
Elephant	Morning	2	2	−0.5	(−2.999, 1.999)	4.5	1.000
	Afternoon	2	1.5				
Impala	Morning	10	12.5	−2.00	(−12.00, 7.00)	35.5	0.6232
	Afternoon	5	10				
Warthog	Morning	2	3.5	−0.500	(−2.000, 1. 000)	4.5	1.000
	Afternoon	2	3				
Waterbuck	Morning	3	1	1.500	(−1.2003, 5.000)	7	0.7469
	Afternoon	2	3.5				
Zebra	Morning	3	6	0	(−8.004, 9.000)	29.5	1.000
	Afternoon	6	5.5				
Kudu	Morning	3	7	−3.00	(−7.003, 2.003)	4.5	0.5536
	Afternoon	2	4				

Mann-Whitney U-test at $\alpha = 0.05$ median abundances between afternoon and morning in the unburnt block. All species showed no significant different between morning and afternoon utilisation of the unburnt site in Matekenya Vlei. Data on buffalo (*Syncerus caffer*), reedbuck (*Redunca arundinum*), bushbuck (*Tragelaphus scriptus*) and Common-duiker were insufficient for Mann-Whitney U-test, however, buffalo (*Syncerus caffer*) recorded three group sighting in burnt area with reedbuck (*Redunca arundinum*) recording two groups only in the afternoon. Individual sighting of common duiker (*Sylvicapra grimmia*) and bushbuck (*Tragelaphus scriptus*) were recorded only in the afternoon.

5. Discussion

Individual species of herbivores in Matekenya Vlei showed variations to habitat utilisation in relation to prescribed burning. Smaller body sized species attracted to burnt areas, while large herbivores favour unburnt area. Even through zebra (*Equus burchelli*), waterbuck (*Kobus ellipsiprymnus*), reedbuck (*Redunca arundinum*), impala (*Aepyceros melampus*) and warthogs (*Phacochoerus aethiopicus*) showed high abundance in burnt areas however only waterbuck (*Kobus ellipsiprymnus*) showed significant difference between the two blocks. Buffalo (*Cyncerus caffer*), eland (*Taurotragus oryx*) and elephant (*Loxodonta africana*) were recorded high in unburnt sites and this was linked to their demand for high forage quantity, whoever there was no significant difference on habitat selection between burnt and unburnt sites.

There was high abundance of small body sized species as well as waterbuck (*Kobus ellipsiprymnus*) and zebra (*Equus burchelli*) in burnt areas compared to unburnt sites. This attraction to burnt areas has been acknowledged elsewhere with numerous animal species throughout the several savannah ecosystems (Onodi *et al.*, 2008) [12]. Archibald *et al.*, (2005) [13] highlighted burnt areas have a

magnetic effect by attracting grazing animals, resulting in heavy selection and use. However, one of the most striking findings of the study is that group abundance of both small and large herbivores did not show significant difference between burnt and unburnt areas except for waterbuck (*Kobus ellipsiprymnus*) which was contrary to the working hypothesis.

Forage quality of plants in recently burned areas can be two to three times greater than areas with longer time-since-fire according to Sensenig and Demment (2010) [14]. Most small bodied animals like impala (*Aepyceros melampus*), waterbuck (*Kobus ellipsiprymnus*) and warthog (*Phacochoerus aethiopicus*) are more diet selective and they need high quality food and not necessarily high quantity. This could be the major reason why large groups of small species were found in burnt areas. However, species such as elephant (*Loxodonta africana*) sightings were high at the periphery of the Vlei in acacia woodlands and at water sources later in the afternoon. Elephant (*Loxodonta africana*) are dependent on eating large quantities of forage which were absent in the burnt sites hence expand their diet to include low-quality forage found outside burnt areas.

Zebra (*Equus burchelli*), impala (*Aepyceros melampus*) and waterbuck (*Kobus ellipsiprymnus*) are regarded as specialised feeders and could be the reason for selecting burnt area in order to maximise quality food from recent sprouting grasses. Though high quality forage is readily available, grazing animals must also make decisions regarding the trade-off between quality and quantity. Additionally, as plant biomass increases, quality and digestibility may decline. Because of species-specific foraging preferences, effects may vary among species and body sizes as shown in different habitat of Matekenya Vlei.

Herds of buffalo (*Cyncerus caffer*), eland (*Taurotragus oryx*) and adult male waterbuck (*Kobus ellipsiprymnus*) were common in unburnt block. Few male waterbuck (*Kobus ellipsiprymnus*) were also recorded in burnt area with bulk of male bulls found in bachelor herds or solitary in unburnt areas. Sightings of male bulls of waterbuck (*Kobus ellipsiprymnus*) may be attributed to response to hunting pressure which targets adult bulls or intra-territorial fighting (Spies, 2015) [15].

Body size for different species could have contributed to habitat selection in Matekenya Vlei. This was linked to animal ability to see predators from a distance or forage quantity requirement and not quality. The findings support observation by Stephanie and Anderson (2014) [4] who indicated that small-sized herbivores may be more strongly influenced by the increase in nutrients and reduction in vegetation height associated with burning compared to large-sized herbivores such as elephant (*Loxodonta africana*) and buffalo (*Syncerus caffer*).

Elsewhere, studies have found contrasting results on the association between preference for burned areas and herbivore body size. Wilsey (1996) [16] found that smaller-sized herbivores (<100 kg) such as impala (*Aepyceros melampus*), were significantly attracted to burned areas, while, larger-sized (>100 kg) such as zebra (*Equus burchelli*) were not. However, finding of this study showed zebra (*Equus burchelli*) were more attracted to burnt area compared to unburnt equally supporting Gureja and Smith (2002) [17] who observed in South Africa that

larger-sized burchell's zebra (*Equus burchelli*) were attracted to burned areas. On the other hand, buffalo (Syncerus caffer), elephant (*Loxodonta africana*) and eland (*Taurotragus oryx*) seemed not influenced by burning and were sighted mostly outside burnt areas, hence agreeing to Sensenig *et al*. (2010) [14] who concluded that there is a negative relationship between body mass and burned area preference.

Even though large groups of impala (*Aepyceros melampus*) were recorded in burnt sites, equally, they were also recorded high in unburnt areas where acacia woodlands are high suggesting other factors influencing habitat selection by common herbivores such as water and predation. Several groups of impala (*Aepyceros melampus*) were sighted under acacia woodlands feeding on acacia seeds. According to Spies (2015) [15], impala (*Aepyceros melampus*) prefer woodland with minimal undergrowth and low to medium height grasslands on flat to moderately sloped landscapes.

Although it is widely known that herbivores are attracted to burnt areas (Eby *et al*., 2014) [18], most herbivore behaviour studies do not include direct effects of fire, but focus on other factors such as water and predation (Beest *et al*., 2010) [19]. Impala (*Aepyceros melampus*), waterbuck (*Kobus ellipsiprymnus*), zebra (*Equus burchelli*) and warthog (*Phacochoerus aethiopicus*) were seen in burnt areas probably because of good visibility and forage quality. Of interest were observations of mixed large herds of impala (*Aepyceros melampus*), zebra (*Equus burchelli*), and waterbuck (*Kobus ellipsiprymnus*) moving in the Matekenya Vlei together. Moving in large groups helps animals to identify enemies from a distance before approaching.

Elsewhere studies have also shown that warthog (*Phacochoerus aethiopicus*) tend to choose burnt areas for feeding (Treydte *et al*., 2006) [20] while seeking cover under bushes (Somers & Barend, 1994) [21]. Warthog (*Phacochoerus aethiopicus*) if disturbed ran into tall unburnt areas whilst other species like zebra (*Equus burchelli*), waterbuck (*Kobus ellipsiprymnus*) and impala (*Aepyceros melampus*) would move from one point to another before eventually escaping to adjacent woodlands. Our findings on warthog (*Phacochoerus aethiopicus*) support research by Wagner (2008) [2] who observed warthog (*Phacochoerus aethiopicus*) were more often found in burnt areas, as could be expected considering that they prefer high-quality grass in Masai Mara and escape to closed tall grasses and bushes when predators and humans approach.

Daily weather conditions such as temperature influence which areas herbivores congregate in, whilst the seasonal distribution is influenced by their requirements for food, rest and water, hence they will move into the Matekenya area to seek sheds, water and forage. This could be the reason for a high recording of large herbivores in the afternoon in both burnt and unburnt areas as opposed to the influence of burning. Several studies have documented temporal drinking patterns of mammals in different regions, with species being classified roughly as either dawn, morning, midday, afternoon or nighttime drinkers. Buffalo (*Syncerus caffer*) and elephant (*Loxodonta africana*) were sited around water points in the afternoon

suggesting they were attracted to both sites by water. The findings agree with those by Hayward and Hayward (2012) [22] who observed in Kruger National Park that mega-herbivore water source peaked from midday to later afternoon while Valeix *et al.* (2007) [23] in Hwange National Park documented that elephant (*Loxodonta africana*) water source use peaked during dusk.

In burnt sites, species of smaller body size, such as warthog (*Phacochoerus aethiopicus*), impala (*Aepyceros melampus*) and reedbuck (*Redunca arundinum*) with other large body sizes such as zebra (*Equus burchelli*) and waterbuck (*Kobus ellipsiprymnus*) abundance was almost similar between morning and afternoon. However, in unburnt areas, warthog (*Phacochoerus aethiopicus*) and waterbuck (*Kobus ellipsiprymnus*) high abundance were recorded in the afternoon compared to morning suggesting utilisation of shed when temperatures rise opposed to forage. No buffalo (*Cyncerus caffer*) were recorded in burnt sites both in the morning and afternoon. Eland (*Taurotragus oryx*) had few groups sighted in burnt areas only in the afternoon at water points and under sheds.

Waterbuck (*Kobus ellipsiprymnus*), warthog (*Phacochoerus aethiopicus*) and reedbuck (*Redunca arundinum*) require an unusually high amount of water (Taylor *et al.*, 1969) [24]. Their habitat preference could have been influenced by proximity to water as well as the quality of grasses found in Matekenya Vlei, for example, buffalo grass (*Panicum maximum*), which grows close to water. As a result, waterbuck (*Kobus ellipsiprymnus*) may have a patchy, ecotonal distribution along the burnt area of Matekenya Vlei the reason for equal sightings between morning and afternoon. The need for a greater water intake may be due to the consumption of mostly protein-rich grasses which are found in burnt areas.

The study acknowledges inclusion of one area of Matekenya Vlei and used line transects in collecting data hence the design is pseudo-replicated on a small scale. However, Matekenya Vlei represents a valuable opportunity to gain knowledge since it hosts a variety of wild herbivores. A number of other factors could be responsible for common herbivore density in Matekenya Vlei such as water and predation as opposed to burning effects.

6. Conclusion

In sum, our results of the study revealed only waterbuck (*Kobus ellipsiprymnus*) showed a significant difference in abundance between burnt and unburnt blocks. Habitat selection is also mostly influenced by body size. It was concluded that prescribed burning might have an important role in modifying forage quality in Matekenya Vlei, hence, should be considered and planned for, as a management measure.

Implications for Research and Practice

This research contributes to the scientific knowledge on explaining how management fires influence herbivore abundance and habitat selection. These have an implication on the planning and management fires as well wildlife distribution

as a response to management interventions.

Future Research

Drawing on the gaps highlighted by this study, studies to answer questions of how long burned areas remain attractive to grazing mammals are recommended.

Authors' Contribution

Mahakata Innocent: Conceptualization, methodology, writing original draft, formal analysis, review and editing. **Mapaure Isaac:** Reviewing and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

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