Temporal Patterns of Utilization of Constructed Water Pans by Different Mammal Species: A study of Mount Kenya Wildlife Conservancy, Kenya

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ABSTRACT

Climate change induced risks like prolonged dry spells are exacerbating water scarcity especially, in the wildlife conservancies calling for alternative water supply systems for wildlife. In Mount Kenya Wildlife Conservancy, water pans were constructed to provide water to animals during wet and dry seasons. The study aim was to establish patterns of water pans utilization by different mammal species in different seasons and times of the day. Study was conducted on the mammals visiting water pans in the dry season (June 2022) and wet season (October 2022) at two water pans in Mount Kenya Wildlife Conservancy. Mammal utilization of water pans was studied using observations and camera traps. Pearson correlation and t-test were used to analyze data. Impala had the highest water pan visitations (36.7%) followed by zebra (22.2%) while eland and reedbuck had the lowest (0.7%) visitations. Morning (0900hrs-1000hrs) was a period of peak visitations, followed by midday while dusk recorded the least visitations. Mammals utilized water pans for drinking, wallowing, grazing, socialization, and soil licking. There were significant differences in the number of visitations between the dry and wet seasons (df =7, t = 2.739, p=0.029) where dry season had high visitations (64.6%) while wet season had 35.4%. There was also a strong negative correlation between mammal visitations to the water pans and the time of the day. The study shows that constructed water pans provide important source of water in protected areas where natural water sources are absent, inaccessible due to fencing, or during the dry season when water is limited. Therefore, water provisioning during the dry season in areas lacking water to increase dispersal ranges in the conservancy reducing mammal concentration around water pans.

Keywords: Utilization patterns, seasons, abundance, mammal activities, duration, water points

1. INTRODUCTION

Water availability influences wildlife distribution, density and behavior in various ecosystems (Sungirai & Gwenya, 2016). Globally, water availability controls daily activities and land use patterns of most mammal species (Sutherland *et al*., 2018). Due to climate change caused by the degradation, destruction, and loss of forests, water is a limited resource for use by mammals (Fullman *et al*., 2017).

Severe drought in African protected areas caused by climate change is threatening species to extinction as it reduces the amount of food and water available for the wildlife species (Kiria, 2018). Low-quality forage and water shortage lead to starvation-induced mortalities reducing wildlife populations (Mpakairi, 2019).

This study was carried out to establish patterns of utilization of constructed water pans by different mammal species. It focused on establishing the seasonal utilization, temporal visitations, various activities and duration of stay at water pans. Artificial water pans are constructed as management tool in protected areas to provide water to mammal species during the dry season, reduce threats to land degradation, to enhance distribution range (Sungirai & Gwenya, 2016), prevent migration of mammals reducing human wildlife conflicts

(Chakuya, 2021), and to increase mammal population and enhance biodiversity (Rispel & Lendelvo, 2016).

Just like any other water sources, utilization of artificial water sources varies according to the species, season and time of the day. Mammals' drinking patterns change in accordance with the distribution of water over different seasons as a result of variations in the availability of surface water (Sutherland *et al*., 2018). The high demand for water by wildlife during the dry season leads to animal concentrations near water sources as ephemeral water sources dry up (Sutherland *et al*., 2018, Trent, 2016). Concentration of mammals around water points increases risks of predation, competition for water resources (Sirot *et al*., 2016), disease transmission, (Webb *et al*., 2022; Titcomb *et al*., 2021), and poor water quality in stagnant water points (Epaphras *et al*., 2008). This leads to dramatic reduction in species numbers hence species population reduction (Tefempa *et al*., 2008; Peel & Smit, 2020).

According to Sungirai &Ngwenya (2016), factors such as distance between foraging areas and water sources, presence of alternative water sources, water quality, and the structure of the surrounding vegetation influence animal's selection of water pan to visit. Additionally, predation risk, competition (Sirot *et al*., 2016) are factors that affect utilization of water points.

In Australia and North America artificial water provisioning has been reported to increase wildlife population, alter wildlife distribution and provide water to wildlife species during the dry season (Harris *et al*., 2020); Eliades *et al*., 2022). In Africa water provisioning is an important management technique in maintaining mammal population in most of the protected areas (Tefempa *et al.,* 2008; Perkins, 2020; Chakuya, 2021; Bennit *et al*., 2022). Artificial water sources have been reported to be of great importance in maintaining wildlife populations and increasing touristic game viewing in South Africa where many studies have been conducted on the utilization of water points by wildlife (Trent, 2016; Sutherland *et al.,* 2018; Veldhius *et al*., 2019; Perkins, 2020). In Zimbabwe, study showed that appropriate planning should be done on water provisioning to cater for the increased water demand by wildlife during the dry season (Sungirai & Gwenya, 2016). Elsewhere in Namibia, water provisioning has been observed as an important tool in controlling mammal distribution preventing the loss of biodiversity in times of food and water scarcity (Rispel & Lendelvo, 2016), and in Tanzania, artificial water sources have been observed to be important since it limits migration of wildlife to areas of high poaching and helps in mitigating human-wildlife conflicts. (Epaphras *et al*., 2008; Tefempa *et al*., 2008).

In Kenya, studies done in Tsavo national park have shown that during the dry season artificial water points provide an alternative water source to wildlife, encourage distribution of mammals into various areas of the park and enhance game viewing for tourist (Ayeni, 1975; Mwazo, 2012; Ngatia, 2015). Just like in Tsavo area, water is a scarce resource for people, livestock and wildlife (Butynski *et al*., 2014) in Laikipia County. Artificial water sources are therefore the main source of water for both wildlife and livestock in ranches (Spira, 2014). For instance, Mount Kenya ecosystem is facing enormous pressure from anthropogenic activities by the adjacent community (Nyongesa & Vacik, 2018). The increase in human population and changing land use in the area have led to declining of forest resources and habitat loss (Poletti, 2016). As a result, Mount Kenya Wildlife Conservancy was fully fenced to protect the critically endangered mountain bongo and other wildlife species from poaching and habitat destruction (Fundi, 2013). Fencing of the conservancy however prevents mammals from accessing natural water sources. Constructed water pans therefore, provide water to wildlife.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Mount Kenya Wildlife Conservancy (MKWC) in Nyeri County, Kenya. The conservancy covers an area of 1250 acres and is located at 0^{0}02'29" S, 37^{0}07'35''E lying at an altitude of 2387m above sea level. It is situated approximately 10 Km from Nanyuki town. MKWC is a privately owned, run as a non-profit organization bordering Mount Kenya Forest and was established to conserve rare and endangered species particularly the critically endangered Mountain bongo. It has also an animal orphanage which is located at the center of the conservancy (Figure 1).

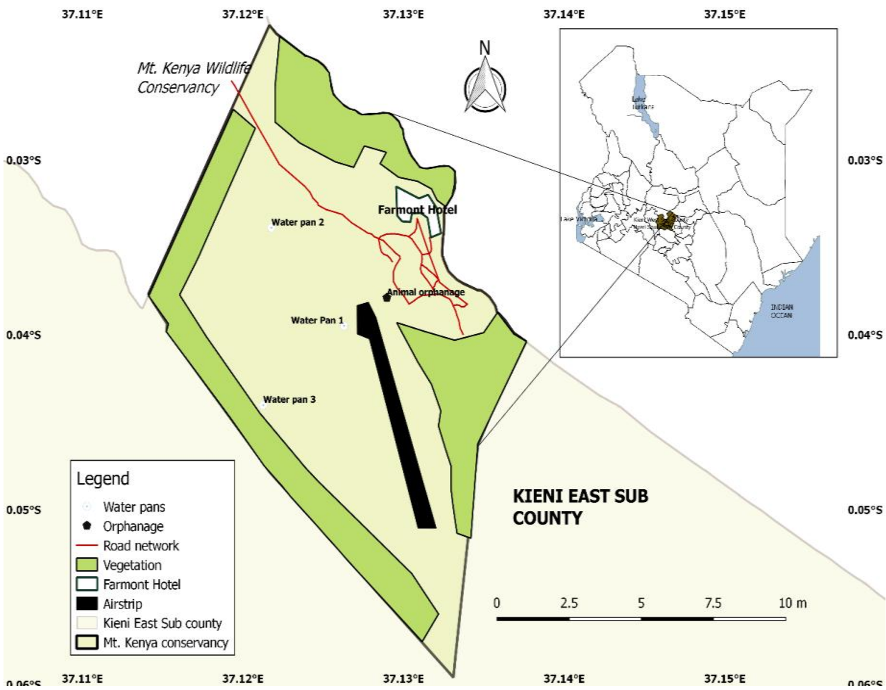

Figure 1: Map showing the location of MKWC and constructed water pans.

The climate of Mount Kenya ecosystem significantly varies with the altitude, forming different belts of communities. Mount Kenya experiences equatorial mountain climate (Jaetzold et al., 2007). The annual mean rainfall is bimodal, with 2,300mm on the windward side and 900mm on the leeward side. Between October and December, the region experiences short rains, while between March and May, it experiences long rains (Fundi, 2013) Vegetation within the conservancy consists of open glades of shrub, herbs and grass.

The mammal population in the study area includes the ungulates such as Cape buffalo (*Syncerus caffer*), bushbuck (*Tragelaphus scriptus*), deffassa Water Buck (*Kobus ellipsiprymnus*), the common zebra (*Equus burchelli*), Suni (*Neotragus moschatus*) and the common duiker (*Sylvicapra grimmia altivallis*). Primates include Mount Kenya guereza (*Colobus guerezakikuyuensis)* being the most common, and olive baboon (*Papio anubis*). Carnivores within the area includes leopard (*Panthera pardus*), spotted hyena (*Crocuta crocuta*), serval cat (*Felis serval*), black backed jackal (*Canis mesomelas*) and the genet (*Genetta tigrina*).

2.2 Sampling

Purposive sampling (Obilor, 2023) was done to select the water pans according to their proximity.

2.3 Data collection

Observations were done from a hide-out overlooking water pans at a distance of 50m and were carried out at the peak of the dry season when animals concentrate around water pans and at the end of the wet season when ephemeral water sources are available in the landscape. At each water pan, observers counted mammals visiting water pans during the day from 0600hrs to 1800hrs, and counts were conducted four times in each season. During the study the following data was recorded species, name, number, arrival and departure time, and other observed activities at the water pan such as drinking, wallowing, feeding, soil licking or, socializing.

Data was collected on a 24-hour basis to determine the pattern of utilization. Observations were carried out during the day while at night, surveillance wildlife camera traps were placed at strategic locations to capture the visiting animals. Arrival and departure time were used in determining the time spent at water pans by each mammal species. In addition, the frequency of occurrence of species at the water pans was determined by the number of individual species per visit, and the time of peak visits of each mammal species was also determined. According to the temporal drinking patterns, species were classified as either dawn (0500hrs- 0700hrs), morning (0700hrs- 1100hrs), midday (1100hrs-1300hrs), afternoon (1300hrs-1700hrs), dusk (1700hrs-1900hrs) or nighttime drinkers (1900hrs-0500hrs).

3. RESULTS AND DISCUSSION

3.1 Mammal Abundance at Water Pans

A total of 892 visitations from 8 mammal species were recorded at two water pans within MKWC during the study period. These mammal species include Buffalo (*Syncerus caffer*), Common Eland (*Taurotragus oryx*), Impala (*Aepyceros melampus*), Reedbuck (*Genus redunca*), Warthog (*Phacochoerus africanus*), deffassa waterbuck (*Kobus ellipsiprymnus*), wildebeest (*Phacochoerus africanus*) and common zebra (*Equus burchelli*). Overall, Impala had the highest abundance at water pans (36.7% of the total visitations recorded), followed by zebra (22.2%) and warthog (16.0%) while Eland (0.5%) and Reedbuck (0.2%) were the least recorded species at water pans (Figure 2). Abundance of species at water pans was determined by their population density in the conservancy. No nighttime species were recorded using camera traps. In addition, the presence of predators was not recorded during this study.

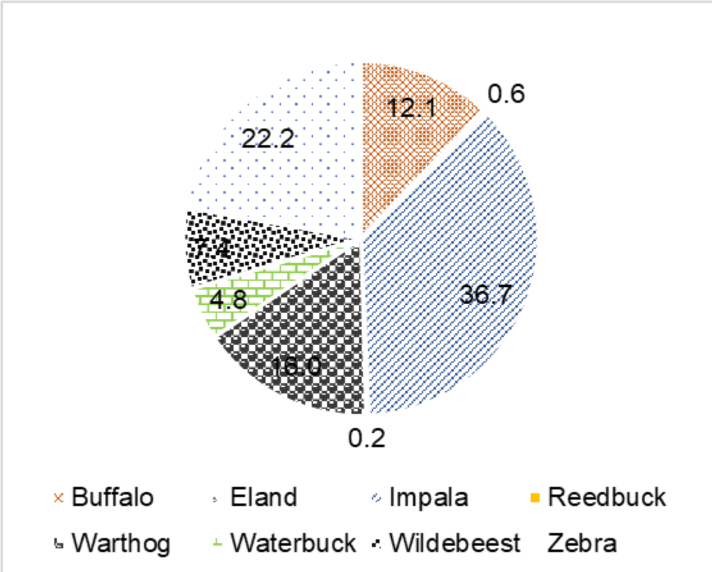

Figure 2: Total abundance (%) of mammal species visiting water pans in MKWC

Out of the total observations recorded, 576 (64.6%) were recorded in the dry season (June 2022) and 316 (35.4%) in the wet season (October 2022) Figure 3. Water pan 2 was the most frequently visited (70.2%) compared to Water pan 1 (29.8%) Figure 4. Paired t-test shows that there were significant differences between Water pan 1 and 2 (df =7, t = -2.78, p=0.027) in terms of mammal abundance. The difference is more likely to be caused by the availability of forage resources. Vegetation around water pan 2 had undergone prescribed burning, providing regrowth of young nutritious vegetation thus attracting many animals near the water pans. On the other hand, forage around Water pan 1 comprised of tall grass and the dominant grass species being *Pennisetum schimperi*, is only palatable during the wet season and turns hard and fibrous during the dry season and thus likely to be avoided by grazers (Sargent, 2016).

According to Trent (2016), forage affects water pan visitation patterns. This provides an explanation why water pan 2 had high mammal visitations. In addition, short grasses around Water pan 2 enabled the increased vigilance in the area which increased utilization. This supports the findings of the study done in Nyae Nyae Conservancy, Namibia which revealed that in order to maximize visibility, animals prefer using water points that are situated in places with low vegetation cover (Rispel & Lendelvo, 2016). Sutherland *et al*., (2018) also reported that animals avoid environments and vegetation types that make them vulnerable to predation.

3.3 Mammal Activities at Water Pans

Drinking (61.22%), drinking/feeding (13.3%), drinking/wallowing (12.55%), and drinking/soil licking (6.84%) were the commonly observed activities by mammals at water pans. Drinking/socialization (3.42%), Drinking/feeding/socialization (1.90%) and drinking/feeding/soil licking (0.76%) were the least observed activities (Figure 3).

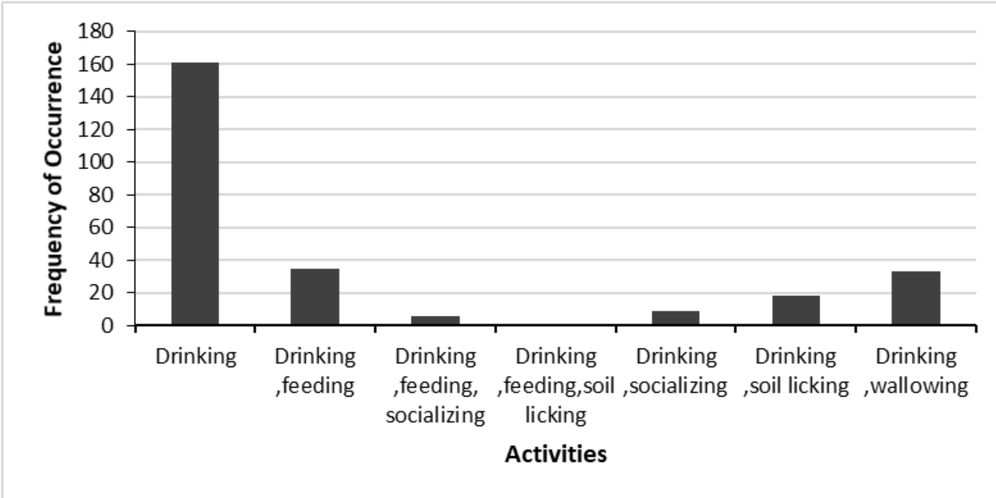

Figure 3: Mammal of activities at water pans in MKWC

Drinking (61.22%) was the most commonly observed activity in all mammal species. This corresponds with the previous study done in South Africa by Smith, (2016) who observed that all herbivore species used water points for drinking. Apart from drinking, soil licking was observed in almost all mammal species. This behavior is known as geophagy (Ajayi *et al*., 2020). Salt licks are used by wildlife for nutritional supplementation (Suberi *et al*., 2022; Mojiol & Lim, 2020). However, overutilization of salt licks by wildlife shows that there is a nutritional deficiency caused by habitat degradation or overpopulation (Suberi *et al*., 2022).

Drinking/socializing was mostly observed in Impala and Zebra (Figure 4). Impala spent the longest time at water pans socializing and soil licking. Buffaloes spent their time drinking and grazing around water pans while zebra after drinking stayed at water pans socializing after drinking. In the afternoon when the temperatures are high, some mammals such as warthogs spent more time at water pans wallowing. Wallowing as a behavior is used as a thermoregulatory mechanism that helps with heat loss when the ambient temperatures are high (Trent, 2016). At this time other animals spend less time at water pans to avoid exposure to direct sunlight.

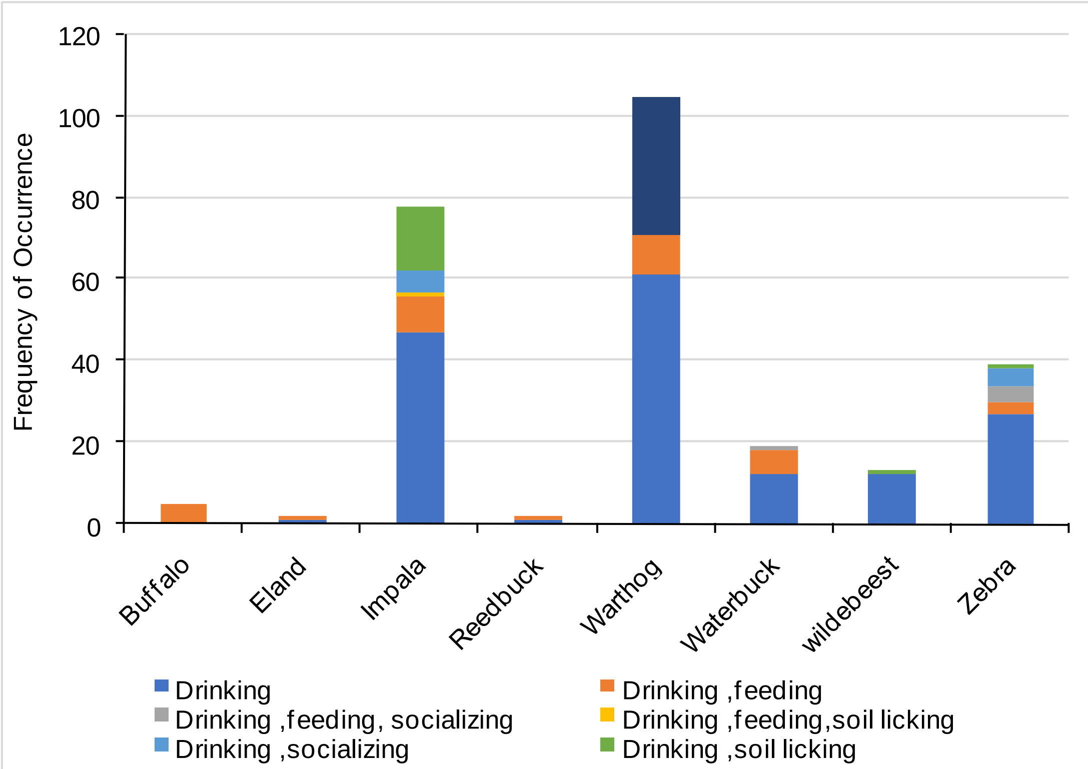

Figure 4: Different activities for each mammal at water pans in MKWC.

3.4 Temporal Utilization Patterns

In this study, mammals showed strict diurnal water pan visitation patterns (0600hrs-1700hrs), showing different temporal partitioning in their water pan visitations (Figure 5). No nighttime species were captured on camera traps. At both Water pan 1 and Water pan 2 majorities of mammal species were recorded during the morning (0700hrs-1100hrs) and midday (1100hrs-1300hrs) 59.62% and 22.06% respectively. Dusk (0500hrs - 0600hrs) had the least visitations.

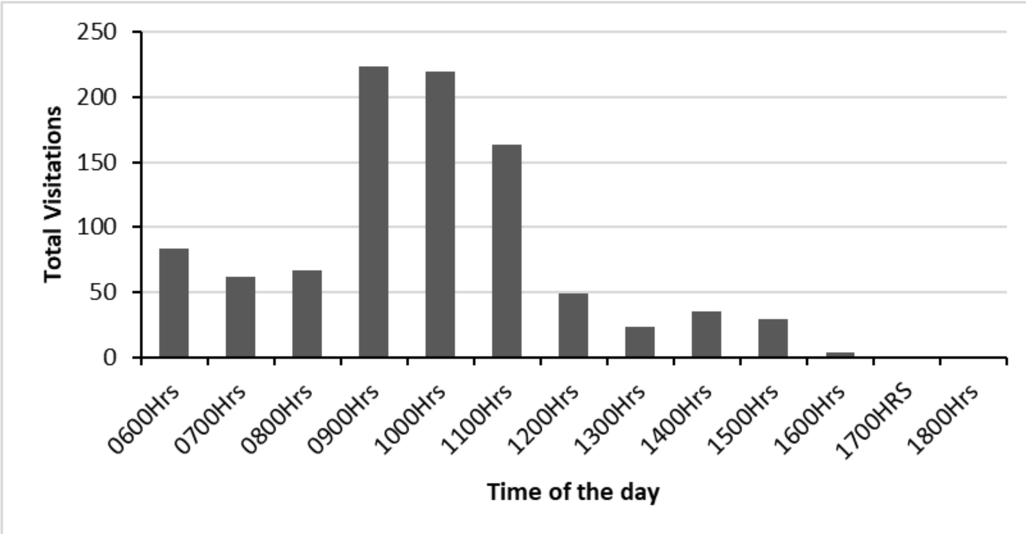

Figure 5: Hourly total visitations for all the species in MKWC.

Climatic and environmental factors have been reported to influence animals' physiological and behavioral responses of species and their water requirements leading to variations in water pan utilization (Trent, 2016). Sutherland *et al*., (2018) and Sirot *et al*., (2016) reported that ambient temperatures influence temporal utilization of water sources where high temperatures reduce the activity of animals during the dry season.

In finding the relationship between mammal visitations to water pans and time of the day, Pearson correlation test shows that there was a negative correlation between mammal visitations to the water pans and the time of the day ($r= -0.535$, $p=0.036$) showing that mammal visitations to water pans decreased as the time of the day increased. Trent (2016) in her study in Kruger National Park reported that mammals adjusted their timing and extent of daily activities to prevent heat exposure and water loss. Similarly, in this study visitations peaked around 0900hr to 1100hrs and were low in the afternoon (1300hr to 1700hrs). This may have been caused by high temperatures at this time causing animals to spend long periods in tree shades. This was also reported by Sutherland *et al*., 2018, who noted that animals were active during morning hours (0600hrs to1100hrs) and avoided hottest time of the day which is afternoon.

Buffalo and Reedbuck visited water pans at dawn and morning. Wildebeest visited water pans in the morning. Impala, wildebeest, and zebra visited water pans in the morning, midday, and afternoon. Impala and warthog had widely dispersed visitations across different hours during the day. All 8 mammal species in the conservancy exhibit diurnal water pans visitation patterns (Figure 6).

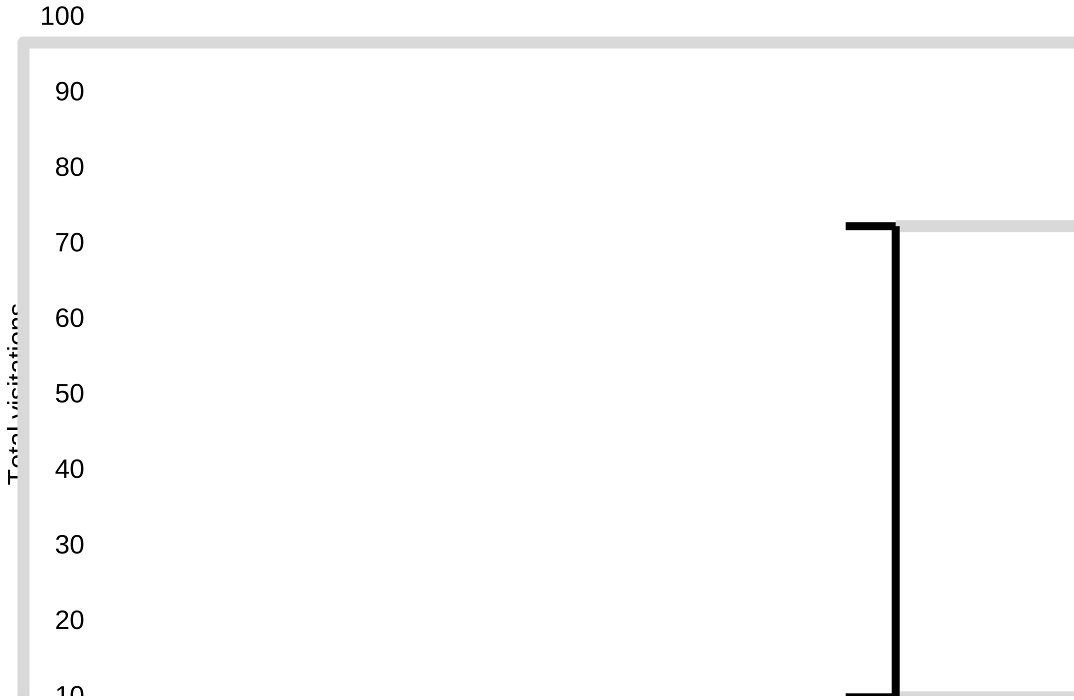

Figure 6: Hourly total visitations for individual mammal species.

3.5 Water pan utilization between Dry and Wet seasons

There were significant differences in the visitations between the dry and wet seasons (df =7, t = 2.739, p=0.029) where dry season had high visitations (64.6%) while wet season had 35.4%(Figure 7). The levels of water pan utilization during the dry season were high due to the drying up of all the ephemeral water sources on the surface and also due to an increase in thermoregulatory needs by mammals caused by increase in environmental temperature compelling animals to drink more frequently to lower their body temperature (Surtherland *et al*., 2018; Eliades *et al*., 2022).

Additionally, Mammals concentrate around water pans during the dry season because of the reduction in the amount of moisture content in vegetation (Trent, 2016). Wet season had fewer visitations since all the ephemeral sources and water sources were filled up with water hence animals were dispersed within the landscape. The findings of this study agree with the previous research done in Malawi by Geneen (2018), who reported that water points were more visited in the late dry season and there were few visitations during the wet season.

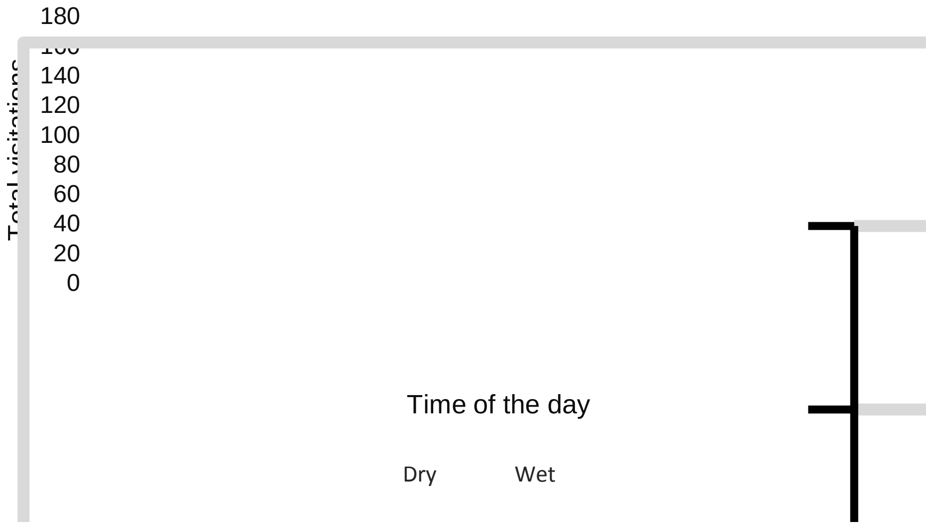

Figure 7: Total temporal variation in water pan utilization between Wet and Dry seasons.

4. CONCLUSIONS

Constructed water pans provide an important source of water and are utilized by mammals in the conservancy during both dry and wet seasons. Utilization of water pans was observed to differ with time of the day, seasons and between species. Water pans were highly utilized by mammals during the dry season than wet season for various activities. Therefore, the study shows that artificial water pans provide important source of water in protected areas where natural water sources are absent, inaccessible due to fencing, or during the dry season when water is limited.

The findings of this study may help in the management of the conservancy effectively under different climatic conditions such as low rainfall, high temperatures and dry season. Further, the study recommends that water provisioning should be done in areas lacking water during the dry season to increase dispersal ranges in the conservancy thus reducing mammal concentration around water pans. The study recommends further research on effects of temporal patterns of visitations on vegetation around the water pans. On the other hand, mammals were observed licking soils on the edges of water pans. Further studies should therefore be done to test for the presence of minerals in the soil and determine how this behavior changes with seasons.

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