Diurnal activity budget and conservation implication of *Hippopotamus amphibius* at Bui National Park, Ghana

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Abstract

Animals apportion time for their daily behavioral activities. We studied the activity budget of *Hippopotamus amphibius* at the Black Volta River in the Bui National Park, Ghana. We performed instantaneous scan sample using ground count survey between August 2020 to July 2021. We observed that *H. amphibius* spent most of their day time resting (54.75 %), followed by feeding (22.93 %), walking (19.2 %) and touching (3.12 %). We found significant difference in the time spent between the daily activities (H = 41.67; $p < 0.0001$). Except activities involving touching, we found no significant seasonal differences in feeding, resting and walking activities by *H. amphibius*. Understanding the behavioral activities of *H. amphibius* will enhance management and conservation of the animals.

Keywords: Common hippopotamus, behavior, semi-aquatic species, daily activities

Introduction

Animals respond differently to stimuli in their environment and this is referred to as behavior (Raven et al., 2008). Animals' ability to find food and water, as well as noticing a mate, predator

or competitor constitutes such stimuli in the environment. Any alteration to an animal's habitat is likely to have an effect on the individuals and subsequently the entire population. To meet the daily requirements for survival and reproduction, animals apportion time for their daily behavioral activities (Timbuka, 2012). One of such species that exhibit different behaviors attributed to changes in their environment is the *Hippopotamus amphibius* (hippopotamus).

The hippopotamus, which is a semiaquatic species is among the mega fauna species. It utilizes two basic habitats including resting in water at day time and grazing on sward during night time (Lewison & Carter, 2004). It plays important ecological role in water and terrestrial ecosystems by enhancing biological diversity of their environment (Eltringham, 1999; Boisserie et al., 2011). At sexual maturity, male and female hippopotamus mate in water and after 8 months of gestation, the female gives birth mostly in water with lower depth (Martin, 2005). The hippopotamus aggregate in groups which depicts irregular distribution caused by the patchy distribution of their feeding and water resources, allowing them to improve their reproduction success (Begon et al., 2006).

The feeding behavior of hippopotamus enable them to consume an amount of 35- 50 kg of grass daily (Chansa et al., 2011). The hippopotamus feed relatively in a solitary manner but when in water they come together and create a bond. This behavior however could change when there is any change in the resources they rely on. In the Bui National Park which harbors a sizable population of hippopotamus in Ghana and the animals spend most of their time and activities in rivers and other water resources (Smuts & Whyte, 1981). As a results of several factors including anthropogenic effects, water and feeding resources have changed in the Bui National Park causing the hippopotamus to react and adjust their behavior to the varying conditions (Timbuka, 2012).

According to Bateson and Martin (1993), activity budget refers to the amount of time an animal apportions to a particular behavioral activity. The diurnal behavioral patterns of the hippopotamus involve behavioral activities and behavioral events. Behavioral activities have a longer period of occurrence including resting, feeding, walking etc. while behavioral events are shorter including barking, yawning, threats etc (Timbuka, 2012). To effectively conserve and manage hippopotamus, it is important to understand the changes in the animals' behavior, especially during changing conditions in the environment.

There exists a gap in literature on changes in hippopotamus' behavior caused by human mediated land-use especially relating to the animal's presence in the Black Volta River of the Bui National Park where a hydroelectric dam has been constructed recently. Therefore, this study aims to establish the behavior of hippopotamus during different seasons. We hypothesized that; 1) The hippopotamus spend more time resting than other activities, and 2) there is seasonal differences in the amount of time spent for the various behavioral activities by the hippopotamus.

Methods

Study area

The study was carried out along the Black Volta River in the Bui National Park (80 23' 13.2072" N, 20 22' 43.9788" W). The Bui National Park is the third largest protected area in Ghana with a size of about 1821 km^2 (Fig. 1). It is one of the few remaining habitats of hippopotamus in Ghana and has very rich flora and fauna resources. The Bui National Park is located within the Bono and Savanna regions of Ghana.

Data recording

We observed and recorded hippopotamus activities twice each month with two weeks' time interval for a period of 12 months from August 2020 - July 2021, daily observation time between

06: 00 am - 18: 00 pm GMT during the dry season (December – March) and wet season (April – November). We followed the hippopotamus using a canoe at a distance of 50 m to avoid disturbing the animals as well as ensuring that we are secured from animal attacks. Animals were observed directly and with the aid of binoculars. When water was so low to use a canoe, we walked at the river-shore.

We used instantaneous scan to observe the animals. Daily study period was divided into four blocks: 06:00-09:00, 09:00-12:00, 12:00-3:00, 3:00-18:30 GMT. Within each block period, we spent 30 mins to observe animals for 5 mins at every 7 mins time interval. In total three hours was spent during daily scans at the site per month totaling 216 hours (3 hrs * 2 days * 12 months * 3 sites = 216 hrs). We recorded by scanning behavioral activities applying methods by Bateson and Martin (1993) and recorded the time spent on activities including resting, walking, feeding and touching.

Data analysis

We summarized data using Microsoft excel and determined any statistically significant seasonal difference between the behavioral activities using Kruskal Wallis test. Monthly differences in activities were analyzed using t - test. Statistical analysis was performed using Paleontological Statistics (PAST) software package.

Results

Diurnal activity budget of hippopotamus

The hippopotamuses were observed to spend most of their day time resting (54.75 ± 1.22 %), followed by feeding (22.93 ± 0.64 %), walking (19.2 ± 0.92 %) and touching (3.12 ± 0.4 %) constituting their daily behavioral activities (Fig. 2). We found a significant difference in the time spent between the daily activities ($H = 41.67$; $p < 0.0001$).

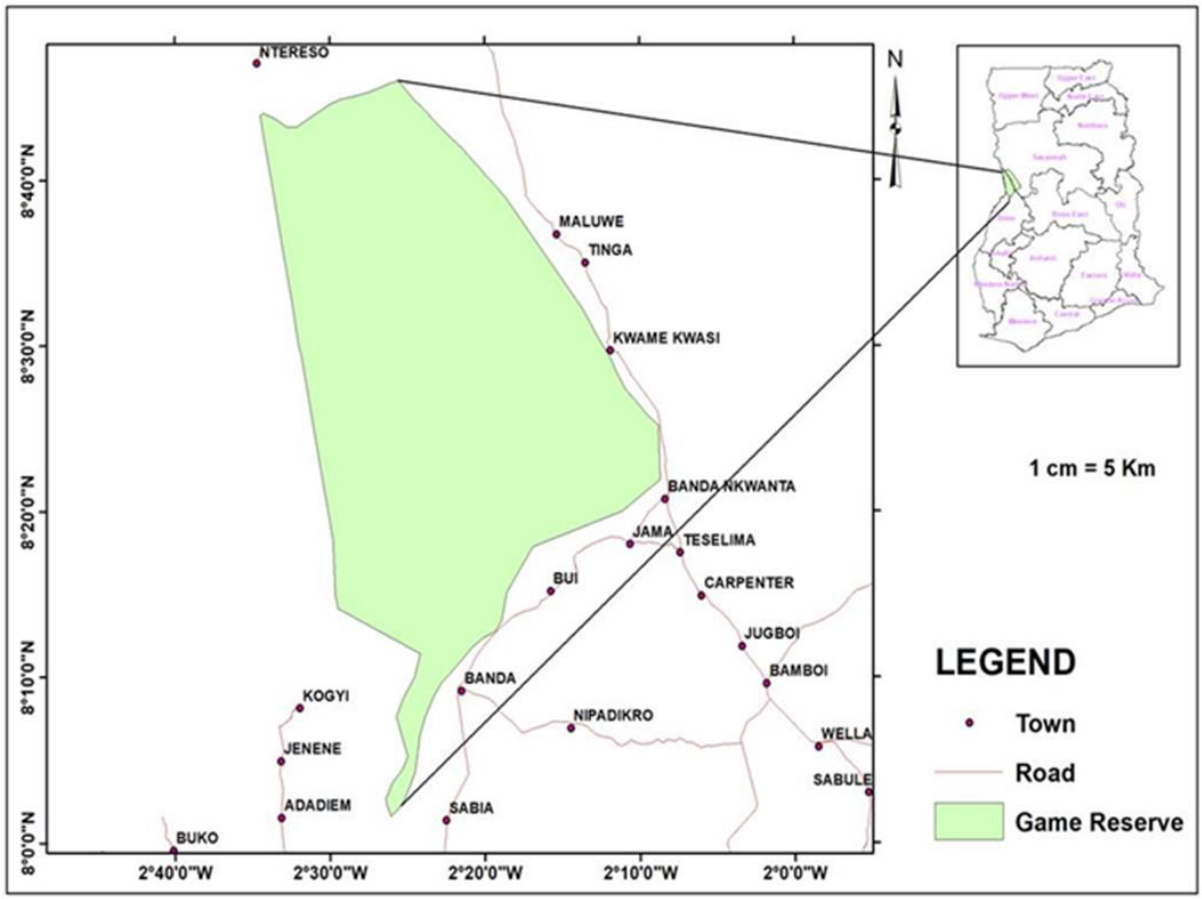

Figure 1: Map of Bui National Park, Ghana

Seasonal differences in activity budget

We found that hippopotamus spend significant amount of time on touching in the dry season than wet season (H = 41.67; $p < 0.0001$) in the Bui National Park. Feeding activities were higher in the dry season (24.15 %) than wet season (22.32 %). Resting activities were higher in the wet season (56.19 %) than dry season (51.87 %, Fig. 3). We found a no significant difference between the wet and dry seasons for activities of resting (H = 2.084; $p = 0.1481$), walking (H = 0.115; $p = 0.7341$) and feeding (H = 1.846; $p = 0.1742$).

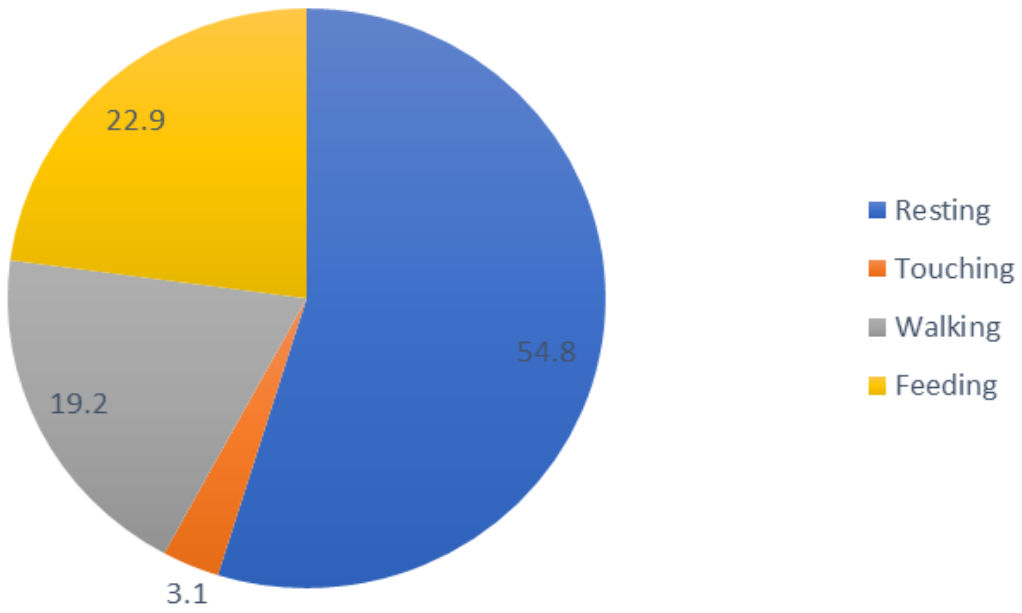

Figure 2. Activity budget of the hippopotamus during the study period

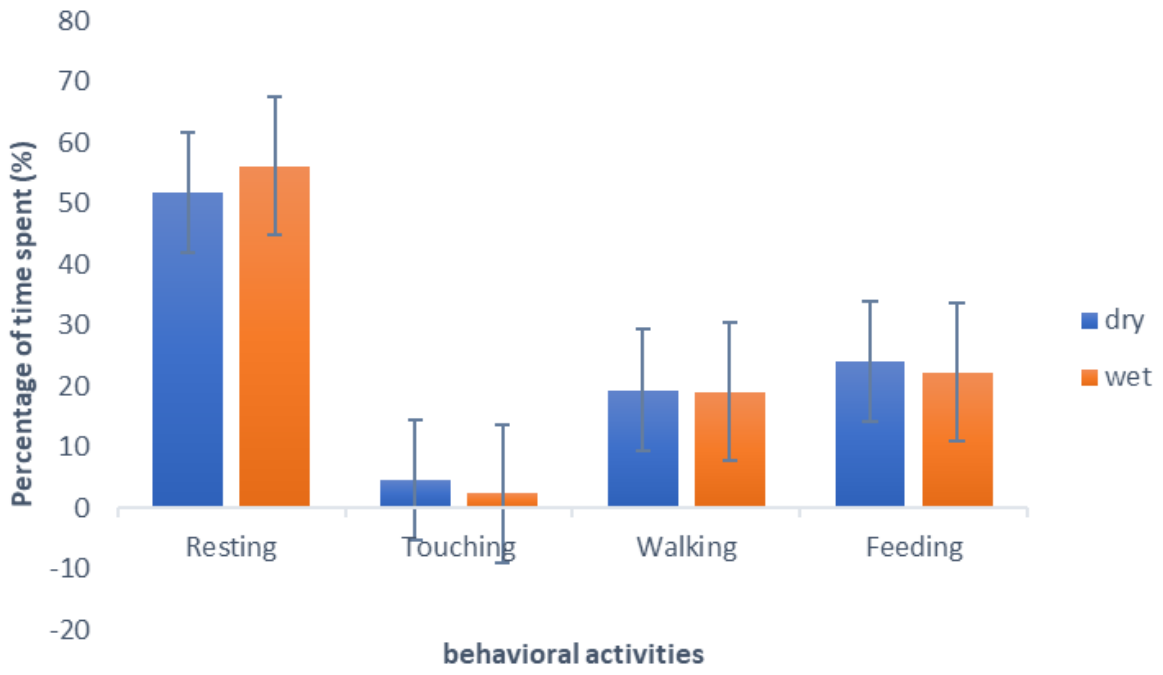

Figure 3. Seasonal differences in the percentage of time spent on the various behavioral activities by the hippopotamus

Differences in monthly activity budget

The time spent by hippopotamuses showed significant differences between the months for resting ($t = 44.872$, $p < 0.0001$), touching ($t = 6.5055$, $p < 0.0001$), walking ($t = 20.855$, $p < 0.0001$), and feeding ($t = 35.9$, $p < 0.0001$). Resting was highest in June with 60.9 ± 1.3 %, while feeding activities were highest in March (25.9 ± 0.6 %), touching was highest in December (6.1 ± 0.2 %) and walking activities were observed to be highest in September (22.9 ± 0.1 %, Table 1).

Table 1. Mean monthly recordings of the activity budget of hippopotamus from August 2020 - July 2021

Month	Resting	Touching	Walking	Feeding
August	58.3 ± 0.8	1.1 ± 0.1	18.7 ± 1.2	21.9 ± 0.2
September	51.4 ± 1.5	1.9 ± 0.2	22.9 ± 0.1	23.8 ± 0.4
October	58.8 ± 0.2	1.2 ± 0.1	17.6 ± 0.5	22.4 ± 0.6
November	55.7 ± 0.4	2.3 ± 0.2	18.3 ± 0.4	23.7 ± 0.2
December	52.4 ± 0.6	6.1 ± 0.2	21.8 ± 0.6	19.7 ± 0.5
January	56.5 ± 1.5	4.1 ± 0.1	12.3 ± 0.3	27.1 ± 0.2
February	51.4 ± 1.4	3.5 ± 0.5	21.3 ± 0.7	23.9 ± 0.2
March	47.2 ± 0.8	4.6 ± 0.4	22.3 ± 0.4	25.9 ± 0.6
April	55.2 ± 1.1	5.1 ± 0.3	19.9 ± 0.1	19.8 ± 0.4
May	50.1 ± 0.9	3.85 ± 0.35	22.4 ± 0.5	23.6 ± 0.9
June	60.9 ± 1.3	2.1 ± 0.2	15.7 ± 0.3	21.3 ± 0.4
July	59.1 ± 1.8	1.5 ± 0.1	16.95 ± 0.95	22.1 ± 0.2

Allocated daily time for activities

Figure 3 shows the percentages of time spent by hippopotamus for various activities at different time of the day. Feeding and walking activities peaked in the early morning (06:00-9:00 am) and in the late afternoon (15:00 - 18:00 hrs GMT). Resting only peaked in late morning (06:00-9:00 am) with 44% and showed constant trend for the rest of the day. Touching was also high in the late morning (06:00-9:00 am) with 25.5% (Fig 4).

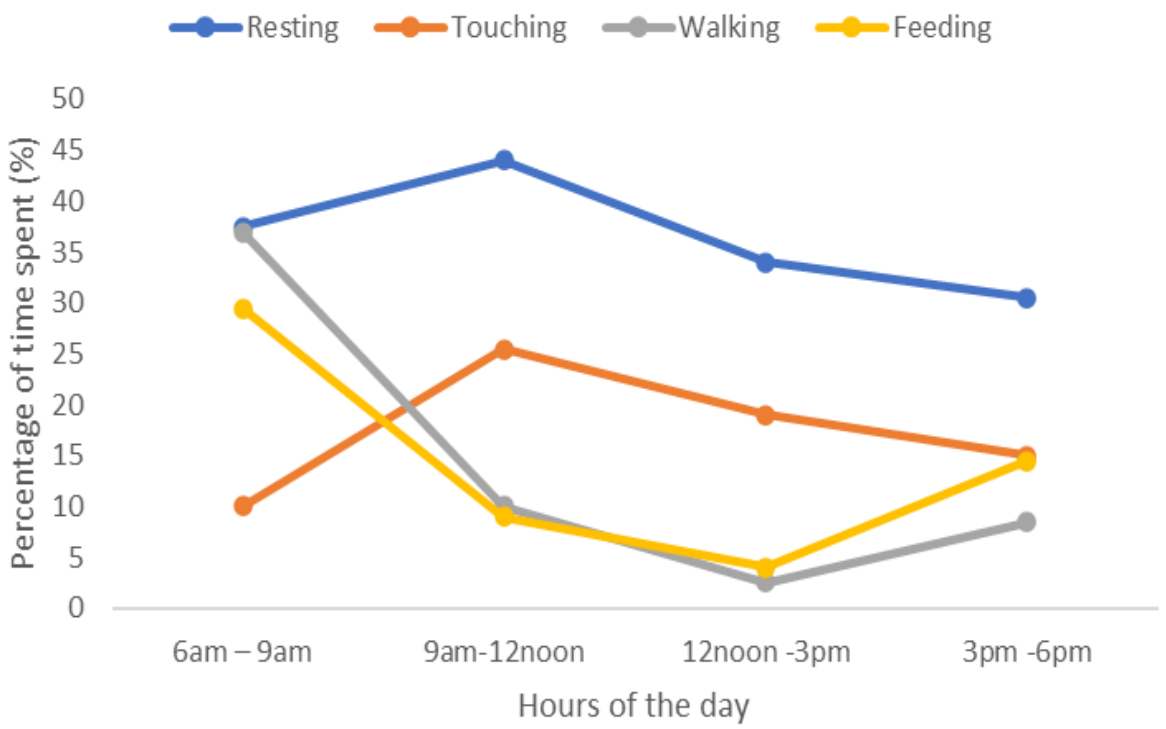

Figure 4. Percentages of time spent by hippopotamus to perform behavioral activities at different time of the day

Discussion

Animals apportion time for their daily behavioral activities. We observed, hippopotamus spent about 54.8 % of their day time resting while almost half of the remaining day time was spent feeding, walking and touching. More feeding activities were performed in the dry season whiles

resting was more prevalent in the wet season than dry season. However, we also found no seasonal difference in resting, feeding, walking, while touching among hippopotamus was seasonally different.

The allocation of time by hippopotamus for their daily activities is similar to results in other studies on hippopotamus (Timbuka, 2012; Mekonen & Hailemariam, 2016). This confirms that hippopotamuses are more active at night than day time (Martin, 2005). We observed that hippopotamus spent almost the same amount of time for both walking and feeding, even though feeding was slightly higher as corroborated in other studies (Timbuka, 2012).

Feeding and walking had similar trend throughout the day. Much feeding and walking activities were performed by hippopotamus in the early morning and gradually with the progression of the day, they reduce feeding and walking, and rest under tree shade or move into the water while touching each other.

During sunny hours of the day, air temperature increases and this propels hippopotamus to rest in water or under tree shades. hippopotamus adopt this strategy to keep their skin from direct sun heat through thermoregulation (Noirard et al., 2008). The hippopotamus feed in the remaining hours of the day only during the wet season or cloudy atmosphere (Mekonen & Hailemariam, 2016). Seasonality affected touching among the hippopotamus as they touched themselves more in the dry season perhaps to maintain the social bond when the amount of water was limited and increased air temperature. We observed that during afternoons, hippopotamuses were mostly submerged in the water (Saikawa et al., 2004) but sometimes came out of the water to stand or rest under tree shades and moved back into the water (Timbuka, 2012).

Seasonality did not strongly affect the activity budget of the hippopotamus as we observed no significant differences between wet and dry seasons for feeding, walking and resting activities.

This means that hippopotamus maintained similar amount of time spent on the various behavioral activities for both wet and dry seasons. Feeding and walking assumed almost the same amount of time. The hippopotamus mostly walked to search for food. Therefore, the proximity of available food resources to the water most likely will reduce the amount of time spent on walking by hippopotamus (Spinage, 2012). We found a significant difference in the amount of time spent touching by hippopotamus between wet and dry seasons with more touching observed in the dry season than wet season. Our observation is in agreement with the findings of Timbuka (2012). This could be attributed to hippopotamus forming bonds during periods of low water availability.

The hippopotamus is noted to graze at night usually spending 12 hrs on feeding (Martin, 2005), however our observation that hippopotamus grazed in the early mornings of the day could possibly be as a results of low food resources availability in the Bui National Park, thus the animals acquired less forage at night, hence more grazing to satisfy nutritional needs and maximize intake of energy (Blowers, 2008). It could also be that they favored the grazing resources available at that specific area and particular time (Timbuka, 2012). The quality and quantity of resources used by hippopotamus most likely affect the diurnal activity budget of hippopotamus (Manteca & Smith, 1994) and hence the amount of time spent on the various behavioral activities.

Conclusion

We observed that hippopotamus spent most of their daily time resting. Feeding mostly occurred in the early morning and was simultaneously performed with walking activities. We did not observe seasonal differences in the amount of time spent performing the various behavioral activities except for touching. This study is important for wildlife managers to understand the various daily behavioral activities of the *Hippopotamus amphibius* and adopt measures for the animals' conservation.

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