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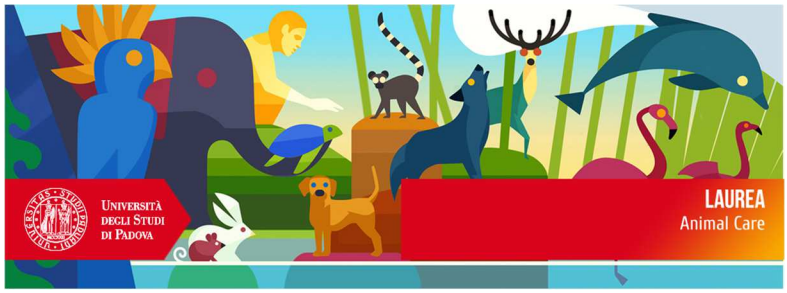

Welfare assessment of zoo elephants in South Africa

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I would like to thank my family for everything they have allowed me to achieve.

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ABSTRACT

In captive settings, physical and social environments, husbandry and care practices, as well as human presence, are considered the main features that can influence animal welfare. The assessment of animal welfare has been frequently based on the analysis of ethological parameters, such as the time budget and the occurrence of abnormal repetitive behaviours. This thesis proposes a preliminary study based on behavioural observation of the three African elephants (*Loxodonta africana*) housed at the Johannesburg Zoo, Randburg, South Africa. The process started with the preparation of a working ethogram based on the literature and adapted to the controlled settings. Data was collected in April 2022 for a total of 3 sampling days with a within-subject experimental design. Each elephant was video-recorded by one observer, for about 8 hours a day with the continuous focal animal sampling method. The recording sessions were scheduled according to the elephants' activities and the battery life of the cameras, in order to have the most reliable and complete daily routine on video, also exceeding the zoo's opening times. The 3 days of recording have then been analysed with the use of the software BORIS. The resulting time budget of the three elephants was consistent with the ones reported in other studies conducted in zoos with the subjects allocating most of the time to food-related behaviours, and to a lesser extent, to locomotion and interaction with the environment. Compared to previous studies, the individuals spent a limited percentage of time inactive, which resembles what has been observed in the wild. The subjects also engaged less in abnormal repetitive behaviours (ARBs), compared to previous research on zoo-housed elephants. Among the three subjects Ramadiba had the highest ARBs percentage which could be also caused by past stressors. These initial results suggested that the provision of diverse food sources and multiple enrichments, especially in some sections of the enclosure, could further improve the welfare conditions of the animals. This study presented a first insight for the detection of potential welfare concerns and laid the groundwork for a bigger project that will consist of further data collection and research, aimed at monitoring the elephants' behaviour and welfare over the long term.

1. INTRODUCTION

Animal welfare has been described by Broom (1996) as 'the state of an animal as regards its attempts to cope with its environment'. Animal welfare encompasses both mental and physical health, involving the interactions with the physical and social environments and the opportunity to exhibit control or choice (Duncan, 2005; Mellor, 2016; Williams et al., 2018; Brando and Buchanan-Smith, 2018; Mellor et al., 2020). This definition states that welfare is a characteristic of an animal rather than something given by man. It also has to do with what the animal feels (Broom, 1996; Hewson, 2003; Duncan, 2005; Volpato et al., 2009) and the naturalness of its living conditions (Hewson, 2003). Welfare lies on a continuous scale between good and poor (Brando and Buchanan-Smith, 2018; Broom, 1996).

In the past, general opinion has seen animal welfare only in terms of the body and the physical environment, as suggested by the biological functioning school, which believed welfare was closely connected with the absence of a physiological stress response. (Duncan, 2005). But this does not provide a complete picture, seeing animal welfare only in terms of the body (Hewson, 2003).

In the last years, animal welfare has been defined as the balance between positive and negative subjective experiences, so that animals are expected to reach a positive welfare state when they mostly experience positive affects (e.g., security and playfulness), their physical and behavioural needs are met, and they can exert choice and control over resources (Mellor, 2016; Mellor et al., 2020).

Based on the literature, the main aspects that can negatively impact the welfare state of subjects under human care are: repeated negative interactions with caregivers and/or visitors, lack of space and enclosure complexity, reduced opportunity to exert choice and control (e.g., where/with whom an animal decides to spend time), and too predictable husbandry schedules (Morgan and Tromborg, 2006; Basset and Buchanan-Smith, 2007; Ward and Melfi, 2015). This can cause the onset of abnormal repetitive behaviours (ARBs), which are defined as 'repetitive, unvarying and seemingly functionless behavioural patterns' (Mason, 1991), and are usually an indicator of poor welfare conditions (Mason, 2006). Elephants are often kept under human care, and there is considerable concern whether captive venues can meet the needs of these highly social and intelligent animals (Brown et al., 2020). Therefore, it is key to promote research studies aimed at evaluating enclosures style and husbandry and care practices to ensure the optimal well-being of animals in our care (Morgan & Tromborg, 2006). This preliminary study fits in a larger one, which purpose is to assess the welfare state in the long term of three adult African Elephants kept at the Johannesburg Zoo (South Africa), through the analysis of behavioural parameters.

2. LITERATURE REVIEW

2.1. Elephant biology

The African savannah elephant (*Loxodonta africana*), is one of the two distinct elephant species living in Africa, together with the African forest elephant (*Loxodonta cyclotis*) (Groves and Grubb, 2000; Grubb et al., 2000; Murata, 2009). It belongs to the order Proboscidea, family Elephantidae, genus *Loxodonta* (Don et al., 2005). It is the world's largest living land animal and it is characterised by key morphological parameters as reported by Grubb and co-authors (2000) (Table 1).

Character	*Loxodonta africana* Bush/Savannah African Elephant		*Loxodonta cyclotis* Forest African Elephant	
Gender	Males	Females	Males	Females
Shoulder height (m)	3.2-4.0	2.2-2.6	2.4-3.0	1.8-2.4
Weight (kg)	4000-7000		2000-4000	
General build	More slender		More compact	
Body build	Back markedly concave		Nearly straight	
Ears general shape	Triangular		Rounded	
Ears lappet	Long, pointed		Short, rounded	
Tusks diameter at base (mm)	155-196	80-119	70-155	57-83
Tusks shape	Curved out and forward		Straight and down-pointing	

Table 1. Morphological parameters comparison between Savannah and Forest African elephant (Grubb et al., 2000).

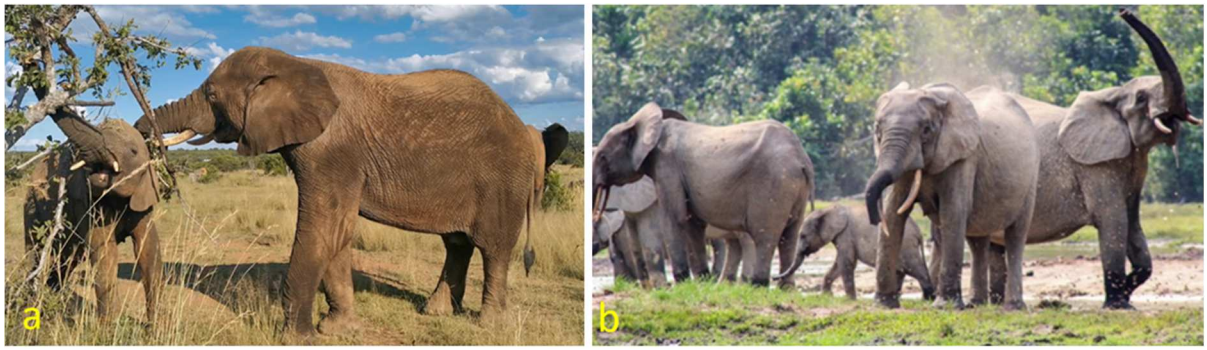


Figure 1. a) African savannah elephant calf and cow at Adventures with Elephants, Bela Bela, South Africa (©Silvia Lucchet). b) African forest elephant family (©Wildlife Conservation Society).

2.2. Elephant range and distribution

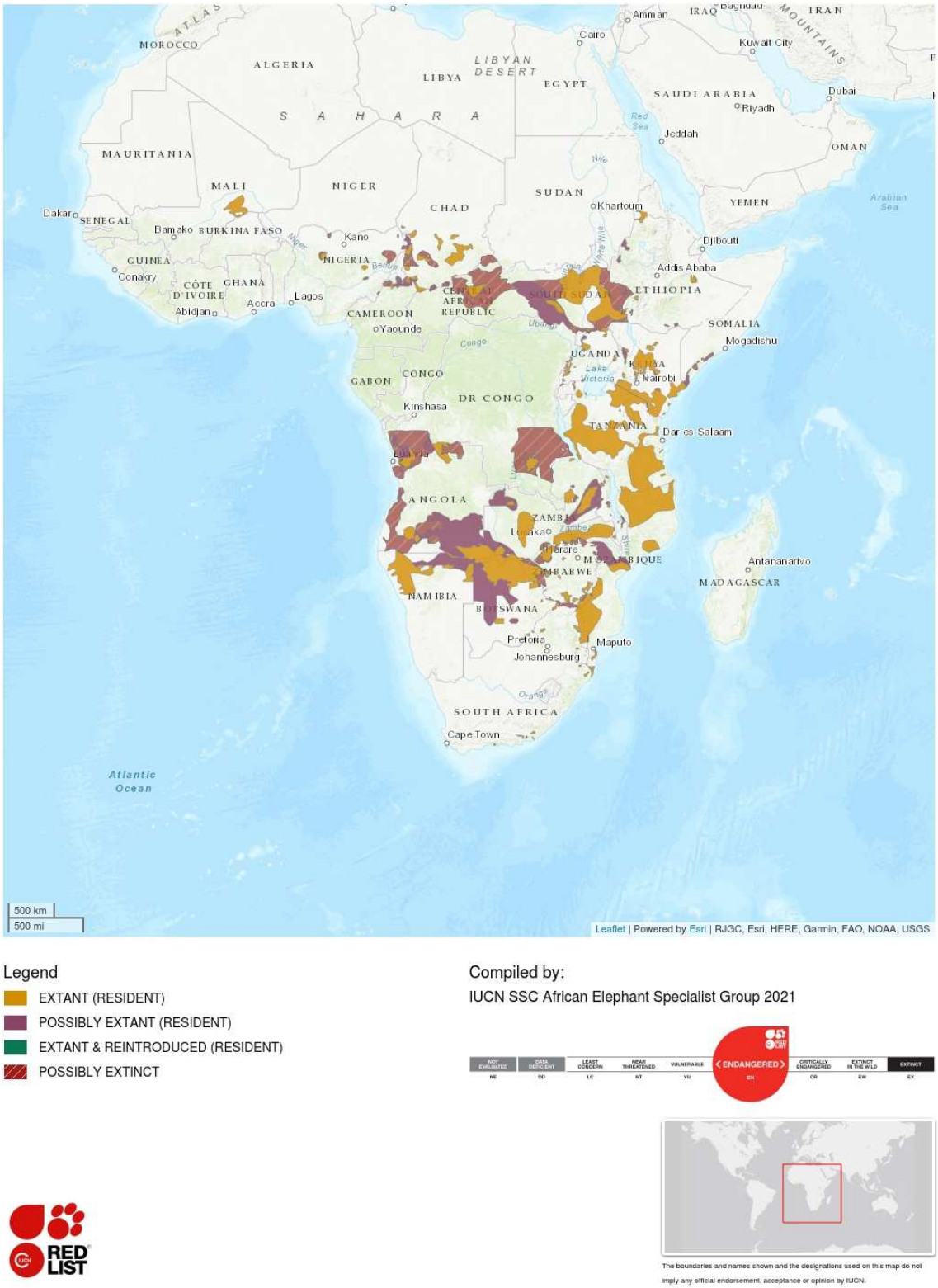


Figure 2 African elephant distribution map of 2021 (©IUCN SSC African Elephant Specialist Group, 2021).

Based on Gobush et al. (2021) African savanna elephants once occurred across all of Africa and are currently found in 24 countries (Figure 2). Even if there are different opinions regarding the species

past/present distribution, nowadays African Savanna Elephants occupy just 15% of their past pre-agricultural range and their distribution is retracting and becoming increasingly fragmented (Gobush et al. 2021).

According to Baillie and his co-authors, in 1996, elephants could be found in Angola, Benin, Botswana, Burkina Faso, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Ghana, Guinea, Kenya, Liberia, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia and Zimbabwe. Instead, referring to the IUCN assessment of November 2020 elephants were not found anymore in Benin, Burkina Faso, Cote d'Ivoire, Equatorial Guinea, Gabon, Ghana, Guinea, Liberia Mauritania, Niger, Senega, Sierra Leone, Togo and Zaire.

The savannah elephant resides on the savannah and grassy plains of East and South Africa, whilst forest elephants inhabit forested regions of Central and Western Africa (EAZA, 2020). A habitat suitability model (Figure 3) showed that 62% of Africa could be potentially habitable by the two African elephant species, but elephants occupied just 17% of the 18 million square kilometres. 85% of potential elephant habitat was laying outside the protected areas. It was the likely range of elephants two millennia before the present. Using GPS tracking from 229 African elephants across Sahel, forest, savannah, and bushveld sites, Wall et al. (2021) showed that protected areas and the human footprint are the main factors affecting elephant range size. This underlines that non-protected areas constitute the majority of elephant range, so that national wildlife authorities are faced with the issue of management outside national parks and reserves as well as within. In the past, human-elephants conflict posed a challenge for conservation, in particular in agricultural areas which were formally uninhabited by humans (Kangwana, 1995). The conflict is increasing today, due to the loss and degradation of habitat and reduced landscape connectivity that force the elephants to have closer contact with human populations (Thouless et al., 2016; Shaffer et al., 2019).

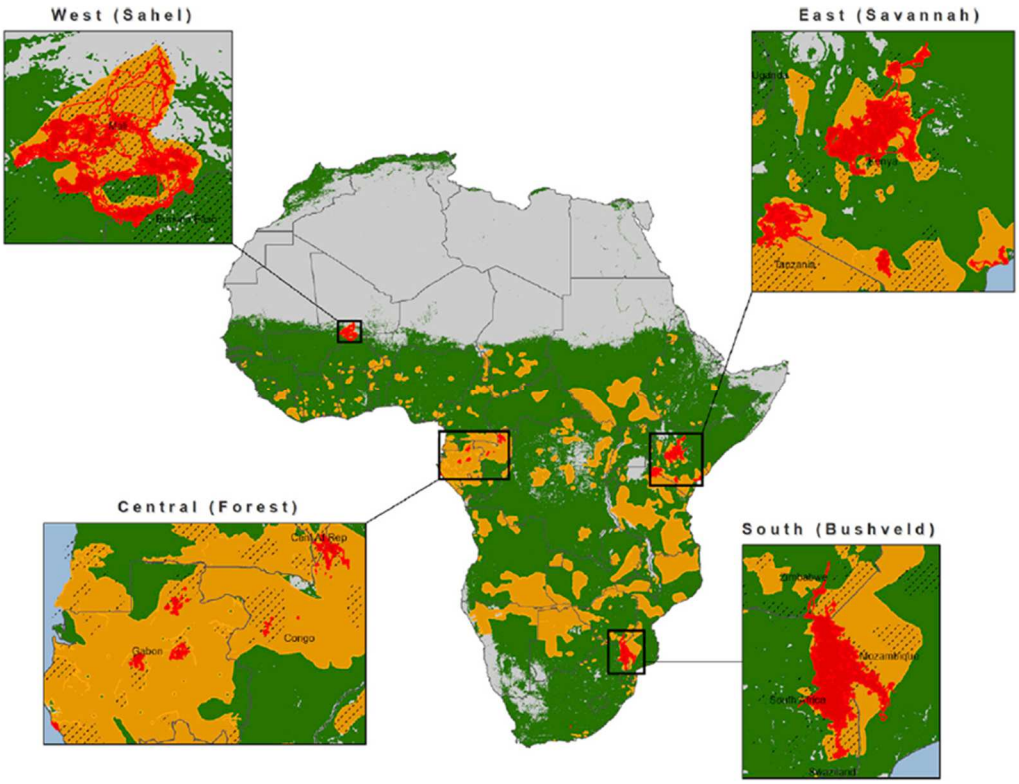


Figure 3 A habitat suitability model for elephants according to the study of Wall et al. (2021).
Orange= elephant range in 2021
Green = suitable habitat
Red= combined elliptical time-density 90th percentile ranges
Black= protected area boundaries

In the AESR 2016 (African Elephant Status Report 2016), the estimated number of elephants in areas surveyed in the last ten years in Africa was 415,428 ± 20,111 at the time of the last survey for each area. There may have been an additional 117,127 to 135,384 elephants in areas not systematically surveyed. There remained an additional 38% of range for which no elephant population estimates were available, although it was likely that average elephant densities in this range were much lower than in the surveyed areas (Thouless et al., 2016).

A study from Thouless and colleagues (2016) highlighted that holding over 70% of the estimated elephants in Africa (56% of estimated and guessed elephants) in 42% of the total range area for the species, Southern Africa had by far the largest number of elephants in any of the four regions. Eastern Africa came second with 20% of estimated elephants (18% of estimated and guessed elephants) in 28% of the range, while Central Africa was an even more distant third (6%) for estimated elephants in 25% of the range. For Central Africa there was a high proportion of guesses accounting for a total of 23% of estimated and guessed elephants. West Africa held the smallest regional population with under 3% of both categories in the remaining 5% of range.

African elephants occur in a wide variety of habitats, from tropical swamp forests to deserts. They often move extensively in search of food, water and minerals or in response to disturbance, and the extent to which they move may depend on a large number of factors. In certain areas, seasonal movements are predictable, while in others, movement patterns are far more difficult to decipher (Thouless at al., 2016). Elephants are likely to actively select habitats (e.g. riverine) providing a range of different resources including water, forage and shade (Duffy et al., 2011). In particular, elephants seem to select habitats on the basis of water vicinity, vegetation types and, when present, elephants preferred areas >4 kilometres from human settlements (Harris et al., 2008).

2.3. Elephant threats

Poaching for the ivory trade, increasing loss and fragmentation of natural habitats, conflict with people over diminishing resources and different human practices threaten the survival and well-being of wild elephants (Elephantvoices, 2022). Poaching of African Savanna Elephants for ivory is a major cause of individual death and population decline (Thouless et al., 2016; Gobush et al., 2021), weighing on African elephants so much that the offtake exceeds the intrinsic growth capacity of the species (Wittemyer et al., 2014), accounting for as many as 30,000 to 40,000 elephant mortalities each year (Wasser et al., 2009). It was estimated that as many as 38,000 elephants were poached in 2006 alone, a number representing approximately 8% of Africa's remaining elephants, far exceeding elephant annual reproductive rate (Wasser et al., 2009). Illegal poaching and trophy hunting can have a significant effect on social organisation and behaviour. Animals with larger tusks are often selected first, which in the past has resulted in a depletion of males and a drop in fecundity of females (EAZA, 2020).

Rapid land use change by humans is driving the direct loss and fragmentation of habitat for African Savanna Elephants and is an increasing threat to populations across their range (Thouless et al. 2016; Gobush et al., 2021). The most critical problems facing African elephant conservation are lack of financial resources for conservation management and growing human populations. In addition, expansion of agricultural activities causes increased degradation and destruction of elephant habitat (Gobush et al., 2021).

Another threat to elephant populations is the capture of wild animals for the commercial sale to elephant-back safaris and circuses, causing the breakdown of elephants' complex relationships, lasting trauma and aggressive behaviour. The process of capture and training does not respect and consider the ethological needs of the species, in fact infants, calves and even adults are rounded up, separated from family and associates (Moss et al., 2006).

Due to the multiple aspects threatening African elephant populations, they (with the exception of the populations of Botswana, Namibia, South Africa and Zimbabwe) are included in CITES Appendix I. The African elephant populations of Botswana, Namibia, South Africa and Zimbabwe are included in CITES Appendix II (CITES, 2022).

The African savanna elephant (*Loxodonta africana*) has been listed since the 2020 as Endangered on the IUCN Red List, while previously, still as a distinct species from the African forest elephant (*L. cyclotis*) was listed as vulnerable in the 2004 and 2008 IUCN updates. In the past, the African Elephant as a single species, (when *L. africana* and *L. cyclotis* were considered a unique species) was listed as Endangered (IUCN, 1996; IUCN, 2022).

2.4. Elephant feeding habits

African elephants (*Loxodonta africana*) are mixed feeders, incorporating varying proportions of grass and browse into their diets. Disagreement persists as to whether elephants preferentially graze or browse, and the degree to which the consumption of these foods is a reflection of their local availability (Codron et al., 2006). Elephants are also considered major ecological drivers in the African savanna, and when populations are at high densities they can have substantial impacts on woody vegetation (Codron et al., 2006; Duffy at al., 2011).

The metabolic rate–body size relationship suggests that the African elephant should be least selective among mammalian herbivores in its diet. However, selection among plant species needs to be distinguished from selection for plant parts or other features. Hence, despite their narrow selection for plant species, large size coupled with hindgut digestion enables elephants to exploit a wide range of plant parts, including fibrous stems, bark, and roots. Accordingly, elephants occupy a dietary niche distinct from browsing or grazing ruminants (Owen-Smith and Chafota, 2012). A Study from Owen-Smith and Chafota (2012) showed that elephants consumed an exceptionally wide range of plant tissues, with almost nothing being rejected when food became scarce during the late dry season. The estimated dietary intake of elephants shifted from 80% leaves or leaf-bearing shoots in the wet season to 94% twigs, bark, and roots during the hot dry season.

According to Guy (1976) elephants spent more time browsing than grazing in both the cold and hot seasons. In the wet season however, there is a change in feeding preference with grazing becoming more important. Grazing continued throughout the whole year and only decreased in importance when the grass became dry and coarse. There was a corresponding increase in browsing as the dry season progressed. The elephants debarked trees only in the cold and hot seasons, but more particularly during the hot season possibly because of the increased translocation of food substances from the roots to the new flushing leaves.

Elephants select a wide range of vegetation, generally eating the species in quantities proportional to their occurrence within the woodlands although some specific trees, shrubs or grasses are positively selected or avoided. Because most of the feeding is carried out on vegetation below 2 m, elephants compete directly with other herbivores occurring in the same habitat where food requirements of animal species in fact overlap. However, males can also account for nine trees each per day in the dry season, or 4,5 trees per day throughout the year (Guy, 1976).

2.5. Elephant social organisation

African elephants have well-structured social relations, living in a matriarchal society (Langbauer, 2000; Wittemeyer and Getz, 2007). They live in a fluid, multi-tiered, fission-fusion society where group membership changes frequently, forming and dividing along lines that may be predicated on different factors including close social bonds, home range, and season (Archie et al., 2006; Poole and Moss, 2008). Also the ecological and social costs and benefits play a role in determining social unit size in fission–fusion societies, for example due to the patchy distribution of resources in savannah ecosystems in combination with their heavy feeding requirements that makes elephants susceptible to intraspecific competition (Wittemyer et al., 2005).

A study from Wittemyer and colleagues (2007) delineated four hierarchical tiers showing different degrees of cohesion and responding differently to temporal and seasonal effects. The most basic elephant social unit is a mother and her offspring (Moss and Poole, 1983). The second-tier is the family unit, which is a group of closely associated breeding females, most probably relatives, and their calves. The third-tier group, also named “bond group”, comprises on average 2.25 family units and 22 (range 6–48). Fourth-tier units seem a function of social rather than spatial processes. On the contrary, Poole and Moss (2008) defined a clan as the fusion of several bond groups and numerous families (reaching up to more than 100 individuals) who share the same dry-season home range (Eltringham, 1982; Poole and Moss, 2008). Clans eventually can combine to form sub-populations that then together constitute the population of an area (EAZA, 2020).

The matriarch, who usually is the oldest and largest female, sets the activity, direction and rate of movement of the herd, also determining the reproductive success in groups (Poole and Moss, 2008).

Like many sexually dimorphic mammals, adult male and female elephants live in very different social situations. Females and their offspring are characterized by complex network of bonds between individuals and families, while fluctuating sexual cycles distinguish the dynamic activities and relationships of males (Poole and Moss, 2008). Females remain in the family unit until reaching the sexual maturity, males instead leave or are forced to leave shortly after reaching it (Moss and Poole, 1983).

Once they reach independence, males form relatively few close and long-lasting bonds with other elephants. Mature males can form small, all-male, rather loose groups or wander alone. During sexually active periods, they then use their senses to rove from one family group to the next and search for receptive females (Poole and Moss, 2008).

2.6. Elephant communication and behaviour

Among terrestrial animal species, elephants have the greatest volume of cerebral cortex available for cognitive processing, allowing this long-lived species to develop many skills involving learning, social learning and memory which includes storing information on conspecifics and the environment it inhabits (Poole and Moss, 2008; EAZA, 2020). Being highly social animals, elephants use a variety of methods to send messages to one another and to other animals (including humans). Auditory, olfactory, visual, and tactile signals all appear to be important in the social life of elephants (Kahl and Armstrong, 2000; Langbauer, 2000). There is also the exceptional possibility of seismic communication, which needs further evidence (Langbauer, 2000). The combination of posture, vocalisations and olfaction provides a sophisticated means of communication (EAZA, 2020).

Elephants are extremely tactile animals and have a wide range of visual and tactile gestures and displays (Poole and Moss, 2008). Family members lean on each other and frequently touch each other with the trunk (EAZA, 2020). The trunk is used extensively in short-distance, tactile communication being mobile, flexible and provided with a highly enervated double finger at the tip. Tactile interactions between individuals occur during a broad range of contexts, such as affiliative and agonistic interactions. For example, an elephant's trunk may be used to assist a calf, to touch or explore the body of a dead elephant, to touch or push another during play. In more aggressive or defensive contexts, an elephant may use its trunk to slap or to block, or to reach out to another individual for reassurance when facing a predator. In sexual contexts trunks and other tactile displays are used to explore, to test or control the movements of a conspecific (Langbauer, 2000).

Elephants send visual signals using their heads, eyes, mouth, ears, tusks, trunk, tail, feet and even their whole body to communicate with each other and with other species. Many visual displays are involved in dominance or aggression directed to a single individual. They usually follow the typical animal model of making the displaying animal look larger, by spreading its ears and holding its head high (Langbauer, 2000).

Regarding vocalisation and hearing, African elephants produce a broad range of sounds from very low frequency rumbles to higher frequency snorts, barks, roars, cries and other idiosyncratic sounds (Soltis, 2010). Ear anatomy appears designed for detecting low frequencies, so that they can respond to rumbles up to 2,5 km away. Two functions have been demonstrated for vocal communication. The

first one appears when closely bonded but spatially separated females engage in ‘‘contact calls”, consisting of rumble exchanges, that function to coordinate movement and reunite animals. The second is shown by both males and females when they produce ‘‘mate attraction’’ rumbles that may advertise reproductive states to the other sex (Soltis, 2010).

The use of chemical or olfactory cues is central to communication between elephants. They often raise their trunks up to sniff scents carried in the air, or use the tips of their trunks to explore the ground (especially urine spots, urine trails and faecal matter) as well as to sniff the genitals, temporal glands, or mouths of other elephants. Chemical communication provides an energetically efficient and long-lasting signal and often complement acoustic or tactile ones (Langbauer, 2000).

2.7. Zoo elephant welfare

In order to maintain good welfare, the animal requires the absence of strong and prolonged negative feelings, the presence of positive ones, and the ability to cope with its environment satisfying its biological needs. (Broom, 1996; Duncan, 2005; Williams et al., 2018; Brando and Buchanan-Smith, 2018).

Nowadays is generally confirmed that people have obligations toward the animals with which they interact, being the society’s ethical concern the driving force for welfare science (Broom, 1996; Duncan, 2005), and that it is up to the people caring for them to evaluate enclosures and husbandry practices to ensure optimal well-being (Morgan and Tromborg, 2006; Brando and Buchanan-Smith, 2018; Binding et al., 2020). For modern zoos animal welfare is becoming more and more important (Binding et al., 2020; Volpato et al., 2009; Brando and Buchanan-Smith, 2018), and its assessment has raised much attention. Dawkins (2003) suggested a two-question approach: ‘Is the animal physically healthy? Does the animal have what it wants?’. But the answer is not simple and the only accepted conclusion is that there is no single measure of welfare (Dawkins, 2003; Basset and Buchanan-Smith, 2007; Yon et al., 2019).

Multiple indicators should be used to assess welfare state (Dawkins, 2003; Duncan, 2005; Basset and Buchanan-Smith, 2007; William et al., 2018; Binding et al., 2020), these are usually divided into three categories: physical, physiological and behavioural indicators. The most used physical measures are general health, foot health (that is a stand-alone parameter) and the Body Condition Score (BCS) (Dawkins, 2003; Williams et al., 2018). The BCS is a numeric scoring system, based on an ordinal 5-point scale. It varies from 1 to 5 with low scores standing for animals with less body fat and higher scores representing animals with more body fat. The “ideal” BCS is 3, the BCS from 1 to 2 indicates “underweight” while “overweight” includes BCS 4 and 5 (Morfeld et al., 2016).

The main physiological indicators for elephant species in literature are glucocorticoids (GC, also indicated as stress hormones) (Binding et al., 2020). These must be interpreted with care because they can also be affected by the sex, age, physiological stage, animal's life history, environmental factors and time of the day (Williams et al., 2018). Instead, for behavioural measures the most validated indicator is the expression of abnormal repetitive behaviours. It should not be used as the sole indicator of welfare because they can have been elicited by past stressors that are no longer present. (Broom, 1996; Dawkins, 2003; Basset and Buchanan-Smith, 2007; Yon et al., 2019). Behavioural analysis is the most used method because it is not invasive and provides information also about positive welfare, other than only about absence of distress and suffering. Thus, behavioural observation is the most suited and used method (Yon et al., 2019; Binding et al., 2020; Basset and Buchanan-Smith, 2007).

Elephant behavioural measures of good welfare includes: variety and presence of species-specific behaviours, behavioural indicators of pleasure (maintenance behaviours), lying rest, positive social interactions, behavioural synchrony within groups, exploratory behaviour, together with a reduction of behaviours indicative of poor welfare (as reduced stereotypies). (Broom, 1996; Williams et al., 2018; Basset and Buchanan-Smith, 2007).

Instead measures of poor welfare are: reduced or excessive sleep, increased stereotypies performance, behavioural attempts to cope, extent of behavioural aversion shown, suppression of natural behaviour, self-mutilation, coprophagy and excessive agonistic behaviour. (Broom, 1996; Williams et al., 2018; Basset and Buchanan-Smith, 2007).

3. RESEARCH AIMS

This research is a preliminary study in a larger one aiming to assess the welfare of three African elephants, housed at the Johannesburg Zoo in South Africa. Through the observation of ethological parameters this project will study the subjects' time budget, behavioural repertoire and enclosure use, to help improve the current management and husbandry practices employed by the hosting institution. This broader project will serve the zoo and welfare managers to pinpoint the crucial aspects of the animals' daily routine, assess whether the enclosure meets the needs of the elephants and identify potential changes to enhance the subjects' welfare.

4. MATERIALS AND METHODS

4.1. Study Subjects

The subjects of this study were three African savannah elephants (*Loxodonta africana*) housed at the Johannesburg Zoo, Johannesburg, South Africa. Lammie was born at the Zoo on the 11th of August 1979, she is the oldest cow and has always lived under human care. Mopane and Ramadiba were both born at a private reserve in Limpopo (South Africa) and acquired together by the Zoo in 2019. Mopane is a 22-years-old cow and Ramadiba is a 26-years-old bull.

During the observation and analysis periods, the subjects were identified relying on the following physical characteristics: number and length/thickness of the tusks, body height, Body Condition Score (BCS), presence of hair on the tail and abdomen appearance (Table 2). The BCS was defined based on Morfeld et al. (2016).

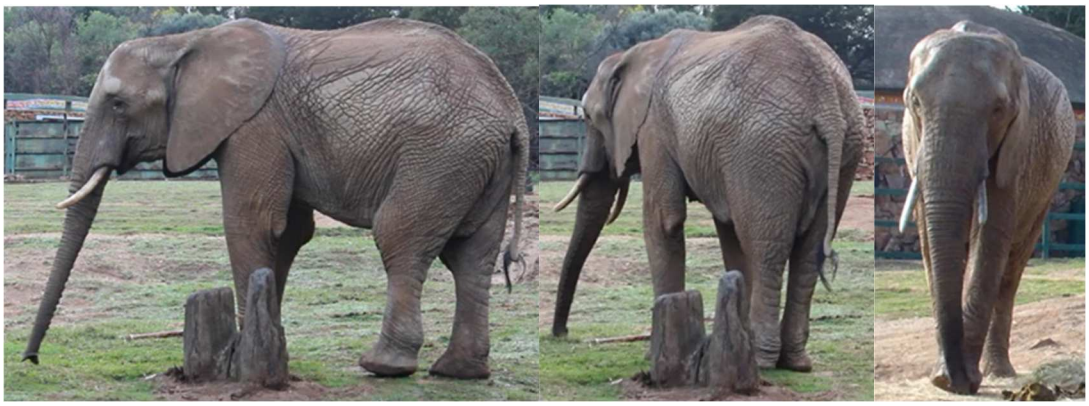
Subject	**Tusks**	**Body height**	**BCS**	**Hair on the tail**	**Abdomen**
Lammie	Left, very short	Tall	5	None	Relaxed
Mopane	Both, long and thin	Tall	4	Many	Tonic
Ramadiba	Both, short and thick	Shorter	5	Few	Tonic

Table 2. Physical characteristics used to identify the subjects.

Photos taken during the observation period of three subjects are reported below (Figure 4).

A. Lammie

B. Mopane



C. Ramadiba

Figure 4. Images of the three elephants: (a) Lammie; (b) Mopane; (c) Ramadiba (©Silvia Lucchet).

4.2. Study area

The elephant enclosure at the Johannesburg Zoo extended on an area of 1,1845 m^2 (1.18 ha) and was composed by five sections (Figure 5) mainly varying in dimension, function and substrate:

-Old enclosure (6,265 m^2; 0.63 ha).

-Night room (100 m^2; 0.01 ha).

-Boma (565 m^2; 0.06ha).

-Bulk room (100 m^2; 0.01 ha).

-New enclosure (4,815 m^2; 0.48 ha).

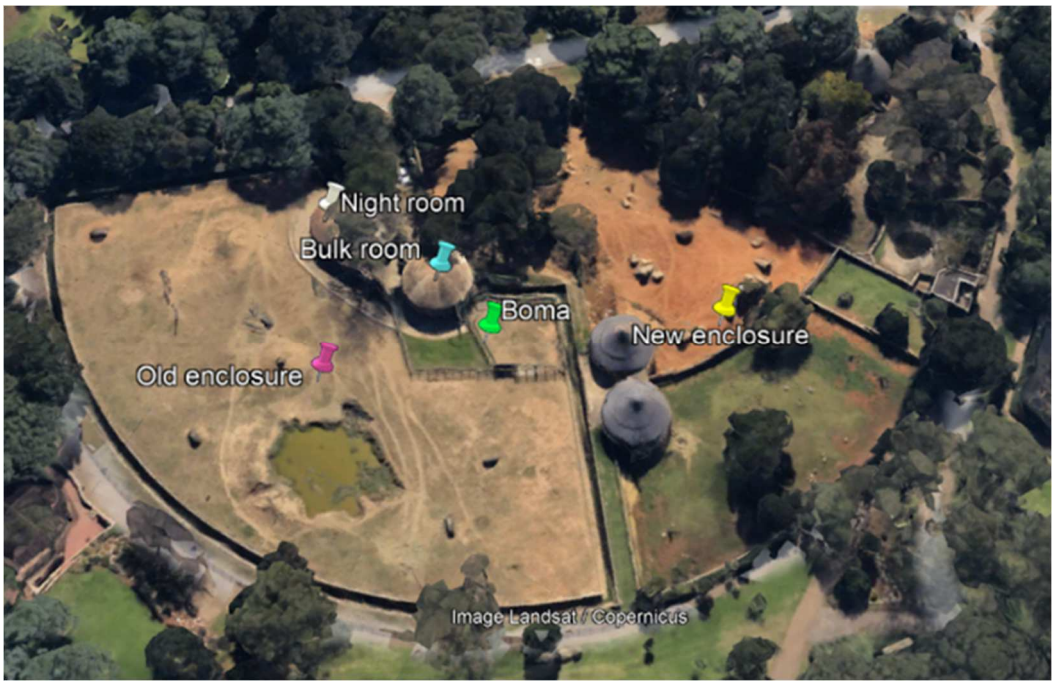


Figure 5. The satellite image shows the five sections of the elephant enclosure (©Google Earth).

The old or main enclosure was surrounded by an empty moat and a wooden fence along the visitor pathway. It was separated from the new enclosure by the moat and a metal gate. Towards the entrance for vehicles and staff there was an internal metal fence in addition to the moat. The night room and the boma were instead divided by a wall, metal fences, part of the boma and service gates (Figure 6, 7 and 8).

Figure 6. Image of the old enclosure seen from the visitor pathway. The buildings correspond to (from left to right): the night room, the bulk room and the boma. The two rooms on the right were previously used for rhinos and were not accessible at the time of the study (©Google Earth).

Figure 7. Image of the old enclosure showing (from left to right) the wooden fence, the moat and the pond (©Google Earth).

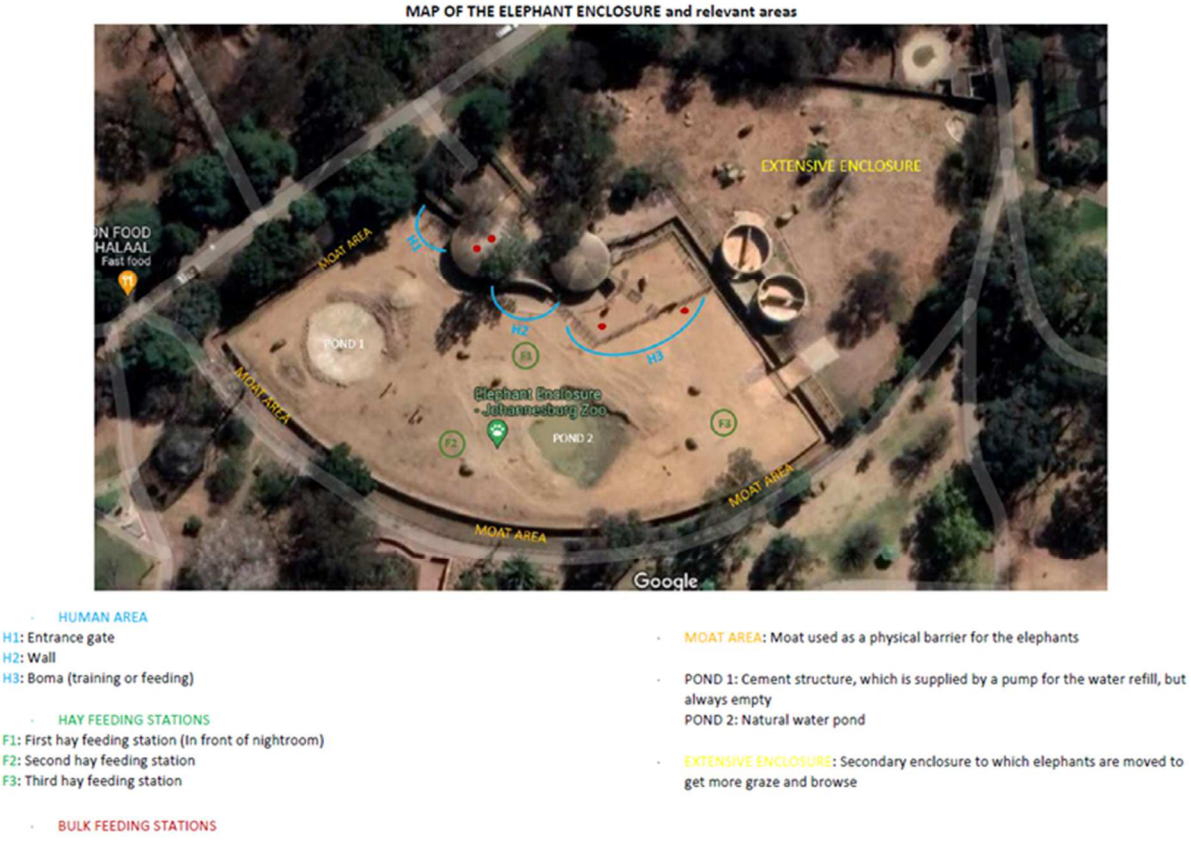


Figure 8. Image of the enclosure showing from above the three feeding points, the two ponds, and the moat; the sand hill is the lighter area between pond 1 and the night room. From the image is also possible to see the areas where elephants mainly interact with people (highlighted in blue), the two rooms, the boma and the new enclosure, which is indicated in the image as 'extensive enclosure' (©Google Maps).

The **old enclosure** and the night room together were accessible to all the elephants every day for most of the day, except for the time dedicated to the cleaning of the enclosure when the animals were kept in the boma. The enclosure was equipped with two ponds, an artificial one, which was kept empty

during the observation period, and a natural one full of water (Figure 8). There were three hay feeding stations located in different parts of the old enclosure and a sand hill which was usually used as an additional hay feeding spot (Figure 8). Six big tires were placed half underground and three poles (one equipped with a feeding enrichment consisting in a long and narrow net, sometimes filled with hay) were also located in the old enclosure. There was one drinking station at the entrance of the night room in addition to the natural pond. The substrate of the old enclosure consisted of low grass or sand. Shrubs and trees were not present in this area.

The **night room** was a circular building with a concrete floor and a roof that provided shadow and a cooler environment.

The **boma** was a rectangular open-topped pen directly connected to the bulk room (Figure 9). Here elephants were kept during the cleaning of the main enclosure and training sessions. The substrate mainly consisted of sand, with the exception of the zone close to the wall of the night room. The perimeter of the boma was fenced with metal bars. Inside the boma there was a drinking station and an internal gate that allowed the keepers to divide the area into two sections if needed.

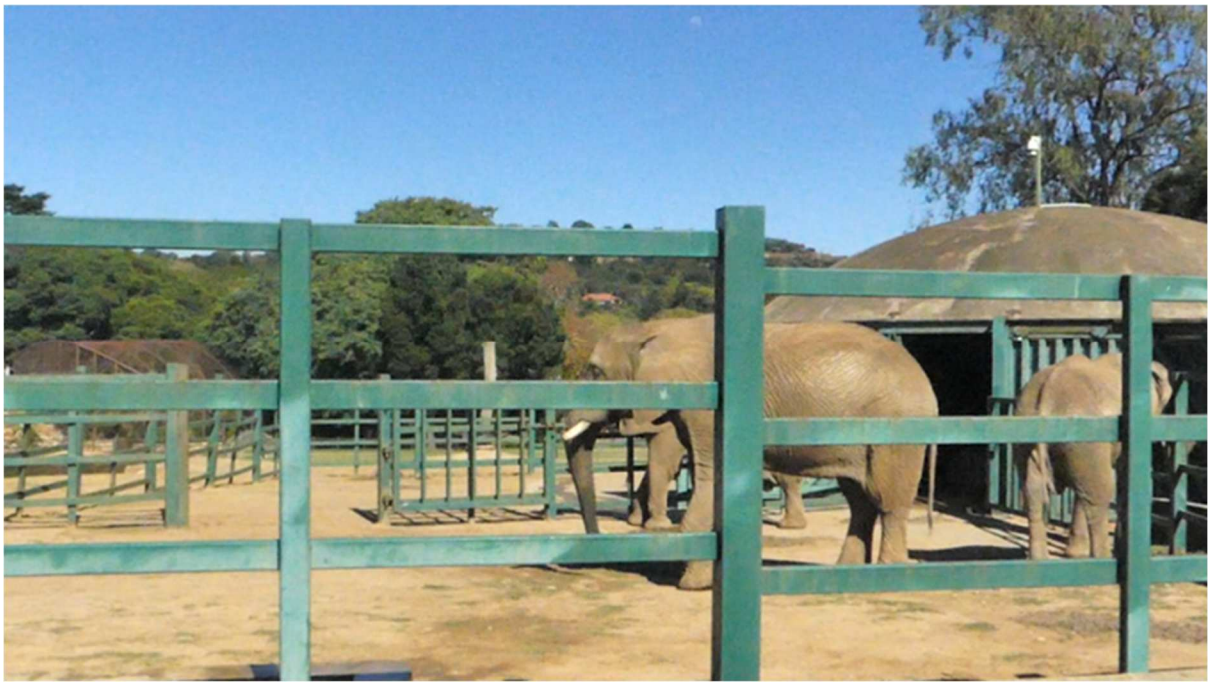


Figure 9. The image shows the three elephants in the boma. It is possible to see the fence and the entrance of the bulk room (©Silvia Lucchet).

The **bulk room** was a round building with a roof and a concrete floor. It was equipped with a fence which could be used to divide the space into two zones if needed. Both the sections were connected to the boma.

The **new enclosure** was lined by a metal fence for the whole perimeter. It was characterised by natural substrate, grass, shrubs and full-grown trees. Additional vegetation was available to the elephant along the perimeter. A gate could be used to separate the new enclosure from the old one if needed.

4.3. Daily husbandry routine

During the three days of observation the elephants had free access to the outdoor area in the main enclosure and the night room, excluding the cleaning time. Cleaning procedures were performed by keepers every day in the morning, leading the animals to the boma and reinforcing with the bulk feed ratio delivery. The bulk portions for each animal were scattered along different points of the area. Otherwise the cleaning of the main enclosure was performed while keeping the animals in the new enclosure.

Graze and water were available *ad libitum* and the daily diet of the elephants consisted of grass, hay, bulk feed (consisting of concentrates, fruits and vegetables) and branches varying in type and amount according to the Zoo's diet sheets. Hay was delivered once a day in the morning, while the keepers were performing the cleaning of the enclosure and the animals were not roaming in the area. In order to avoid competition for food among the subjects, the hay was scattered in different parts of the enclosure, including the three feeding stations and the top of the sand hill. Furthermore, it was sometimes randomly hidden in the enclosure, aiming at increasing the time allocated by the elephants to foraging and feeding, serving as a form of enrichment. The bulk feed was provided twice a day in different points of the old enclosure or of the boma. Branches were provided in the old enclosure in different moments of the day following a randomised schedule, whereas in the new enclosure the elephants could feed on grass, branches and other natural vegetation naturally available.

The new enclosure was made available for the animals to freely roam without a fixed routine during the period of observation, but never for the entire day and at night.

Enrichment items were selected and rotated without a fixed schedule by the enrichment manager, who chose different types of activities and objects to increase mental stimulation of the animals and/or to encourage natural species-specific behaviours. As an example of food-related enrichment, keepers used to fill with hay a narrow net, which was aimed at stimulating play and increasing foraging time. Browse was also provided as branches to enhance the time spent performing food-related behaviours. In the whole enclosure there were several big tires and poles fixed to the ground to stimulate exploration behaviour and provide the animals with additional surfaces to scratch their bodies. More smaller tires were hung along the walls of the bulk room and some were placed chained to the walls of the night room.

Training was also part of the enrichment schedule, and during the observation period it was performed once, in the morning, during the cleaning time. There was one staff member for each animal standing on the outer side of the boma while the elephants were inside. The training session lasted approximately 15 minutes and was based on positive reinforcement training techniques.

4.4. Ethogram

A preliminary period of observation (from 03.04.2022 to 06.04.2022) of elephants kept in semi-captive conditions (at Adventures with Elephants, Bela Bela, South Africa) was carried out prior to the data collection to gain more skills in behavioural data collection. The two days of preliminary observation were conducted at at the Johannesburg zoo using the '*ad libitum* sampling' method (Martin and Bateson, 2007) to learn how to recognize the three individuals and to develop an ethogram specific to this study, integrating the available scientific literature (Poole and Granli, 2011; Jeffrey, 2017; Yon et al., 2019; Pollastri et al., 2021; Poole and Granli, 2021). The behaviours listed in the final ethogram were divided into 'states', i.e. behavioural patterns of relatively long duration (e.g. walking and feeding), and 'events', namely behaviours which can be approximated as points in time (e.g. head shake and ear flap) (Altmann, 1974; Martin and Bateson, 2007). The complete study ethogram consisted of 14 behavioural categories containing in total 100 behavioural patterns (Appendix A, Table A).

4.5. Data collection

Data collection was performed by one observer (equipped with a camera and a tripod) for each elephant. The videotaping was distributed along the day from 06.00 to 17.30 with a total duration of about 8 hours per day. Data collection was conducted from 19.04.2022 to 21.04.2022 and was carried out using a within-subject experimental design (Lehner, 1996). The elephants were video-recorded to ensure an exhaustive monitoring of their behaviours (Friard and Gamba, 2016). During the three days, six observations were conducted daily according to the following schedule (Table 3):

Observation number	Start & end time	Tot duration
1st	06.10-07.20	1h10’
2nd	08.00-09.20	1h20’
3rd	09.50-11.10	1h20’
4th	11.40-13.00	1h20’
5th	14.20-15.40	1h20’
6th	16.10-17.30	1h20’

Table 3. Scheduled observation sessions along the 3 days.

Video-recording was carried out using three camcorders (Samsung OIS DUO, Lumix DMC-FZ 300, and Canon EOS 600D) installed on tripods. Videos were recorded from along the elephant enclosure fence, or the inside of the boma, when accessible, or the roof between two night rooms not in use, in accordance with elephants movements and visibility. Data was collected with the 'continuous focal animal sampling' method, which implies the continuous observation of a 'focal' individual for a specified amount of time (Martin and Bateson, 2007). A total of 54 focal sessions were obtained, 18 for each subject, resulting in an average of 23 hours of observation per individual and a total of 69 hours and 41 minutes of video-recording.

5. ANALYSIS

5.1. Video and data analysis

Video-recordings were analysed using the Behavioral Observation Research Interactive Software (BORIS) version 7.13.8 (Friard and Gamba, 2016).

"BORIS integrates a highly customizable and flexible interface with time-constrained event logging that can be managed by pressing the keys on the keyboard" (Friard and Gamba, 2016). The software enables users to upload the study ethogram and to associate each behaviour listed with a keyboard key. This is then used to log the behavioural patterns during the analysis directly typing the right key to insert the specific behaviour. It is possible to upload one or more observations and to name each file according to the study necessities (e.g. in this study three observations were uploaded together constituting one session, then named with the recording time and date). The program allows the user to select the focal subject. Furthermore, it is possible to add one or more 'sets of modifiers' to each behaviour to simplify the coding and reduce keys number. Modifiers can be used to add attributes to behaviours that help the researchers to understand some preferences of the animals or specific conditions such as the time spent alone or in a group and where (Friard and Gamba, 2016). The following four sets of modifiers were created:

- use of the five enclosure sections by the animal,
- subjects' spatial proximity, with respect to the other two elephants,
- receivers of behaviours, listing the other elephants, inanimate objects or other animals,
- human-animal interactions, stating if the action involved the caregiver, the observer or the visitors.

The first two modifier sets were added to each behaviour, while the last two were created for some specific behaviours like 'trunk forward' or 'push' which can be directed toward something or someone (Figure 10).

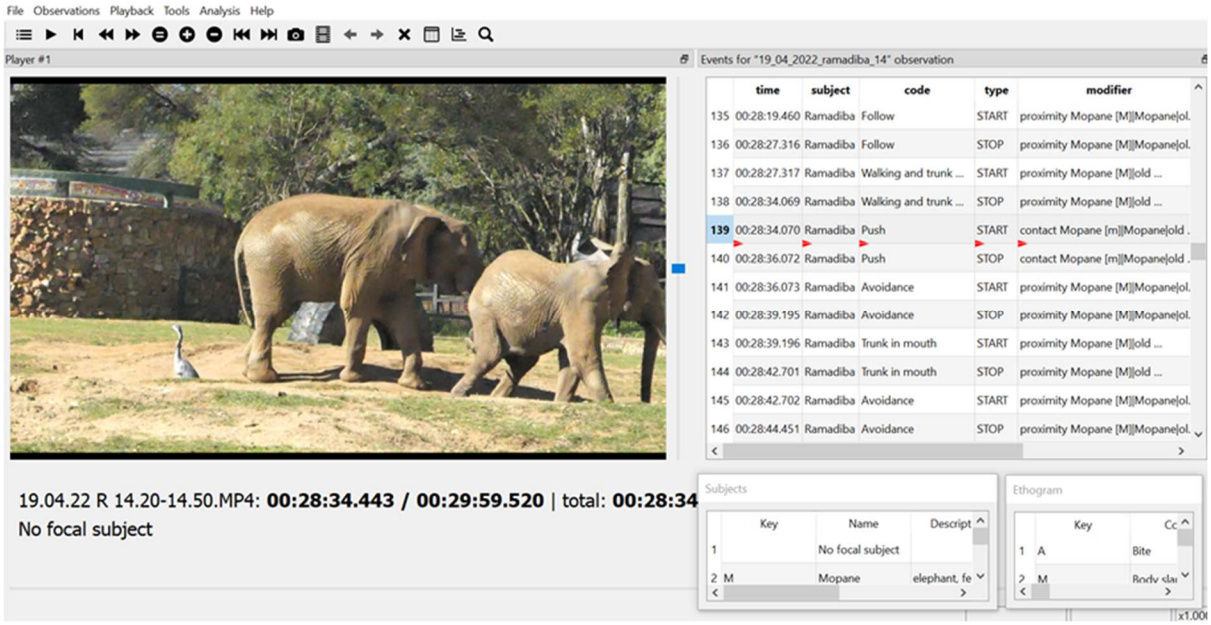


Figure 10. Coding of the behaviour push performed by Ramadiba towards Mopane (©Silvia Lucchet).

Data obtained from the video-analysis were exported to Microsoft Excel 2010 spreadsheets and then used to calculate the proportion of time dedicated by each subject to 'states' (behaviour duration/observation time) and the relative frequency of 'events' (number of events/observation time).

State behaviours were used to calculate the time budget of the animals, indicating the percentage of time each elephant allocated to the different behavioural categories. Instead event behaviours were analysed separately. Time budgets are reported as bar charts whereas events are presented with pie charts.

6. RESULTS

6.1. Overall time budget

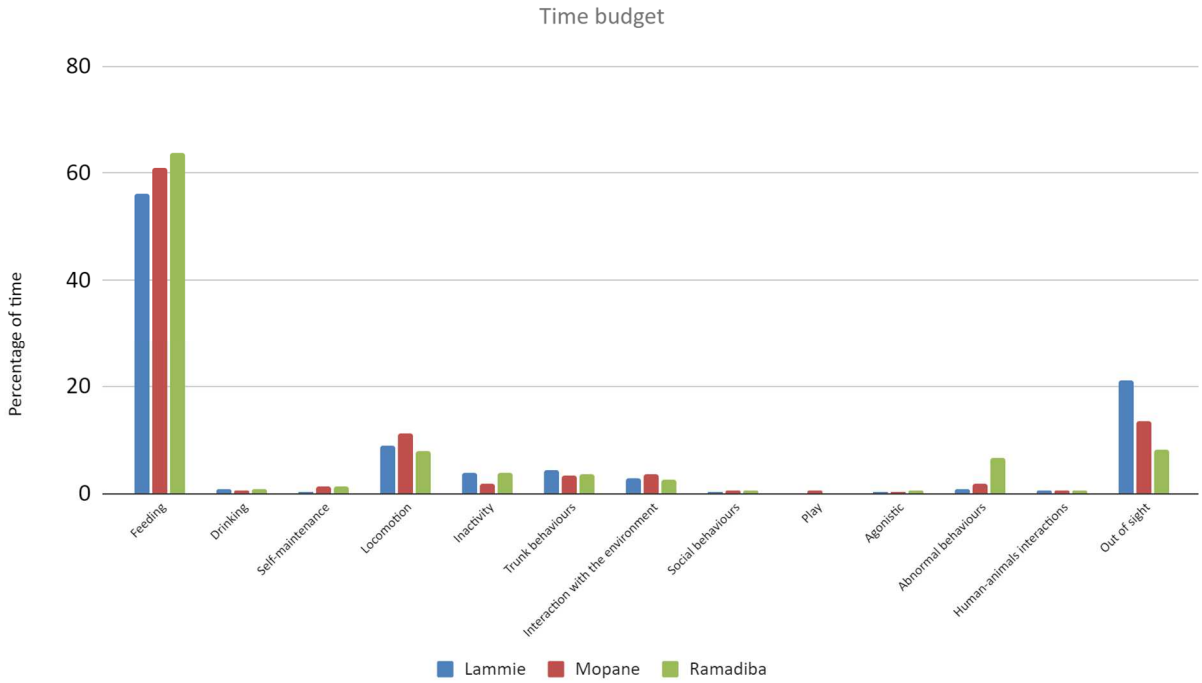


Figure 11. Bar chart showing the percentage of time allocated by each subject to the different behavioural categories.

Elephants allocated a small portion of time to inactivity, which encompasses lying and standing (Lammie, 3.74%; Mopane, 1.85%; Ramadiba, 3.75%). An average of 3.39% of the time budget corresponded to trunk behaviours (Lammie, 4.22%; Mopane, 3.21%; Ramadiba, 3.58%) and 2.94% to interaction with the environment (Lammie, 2.73%; Mopane, 3.61%; Ramadiba, 2.47%).

Lammie spent 21.04% of the time out of sight, followed by Mopane (13.51%) and Ramadiba, which was visible for most of the time (*out of sight*= 8.23%). The animals also showed a rather small percentage of abnormal repetitive behaviours (Lammie, 0.77%; Mopane, 1.80%; Ramadiba, 6.65%).

The remaining behavioural categories (*drinking*, *self-maintenance*, *social*, *play*, *agonistic*, *human-animal interaction*) accounted for less than 4% of each animal's time budget (Lammie, 2.36%; Mopane, 3.74%; Ramadiba, 3.53%).

6.2. Time budgets for each enclosure section

The time budget for the three subjects was calculated singularly for each enclosure section.

In the old enclosure (Figure 12) and the new enclosure (Figure 13), which are the two extensive areas where the animals spent the majority of observation time, the most represented behavioural category was food-related behaviours. In the new enclosure Lammie spent 81.29% of the observation

time in feeding and foraging behaviours, followed by Ramadiba and Mopane with respectively 77.53%, and 72.51%. In the old enclosure the percentages of feeding and foraging behaviours were from 8.03% (for Ramadiba) to 20.24%, lower than in the previous ones, but still represented the most observed category.

Locomotion was performed more in the old (Lammie, 12.09%; Mopane, 12.96%; Ramadiba, 8.45%) compared to the new enclosure (Lammie, 2.95%; Mopane, 7.24%; Ramadiba, 5.63%), as for the other behavioural categories (drinking, self-maintenance, social, play, agonistic, human-animal interaction).

Abnormal repetitive behaviours were almost absent in the new enclosure and were rarely shown in the old enclosure, with Ramadiba (6.63%) performing them the most compared with Lammie (0.99%) and Mopane (ARBs= 0.99%, 1.28%).

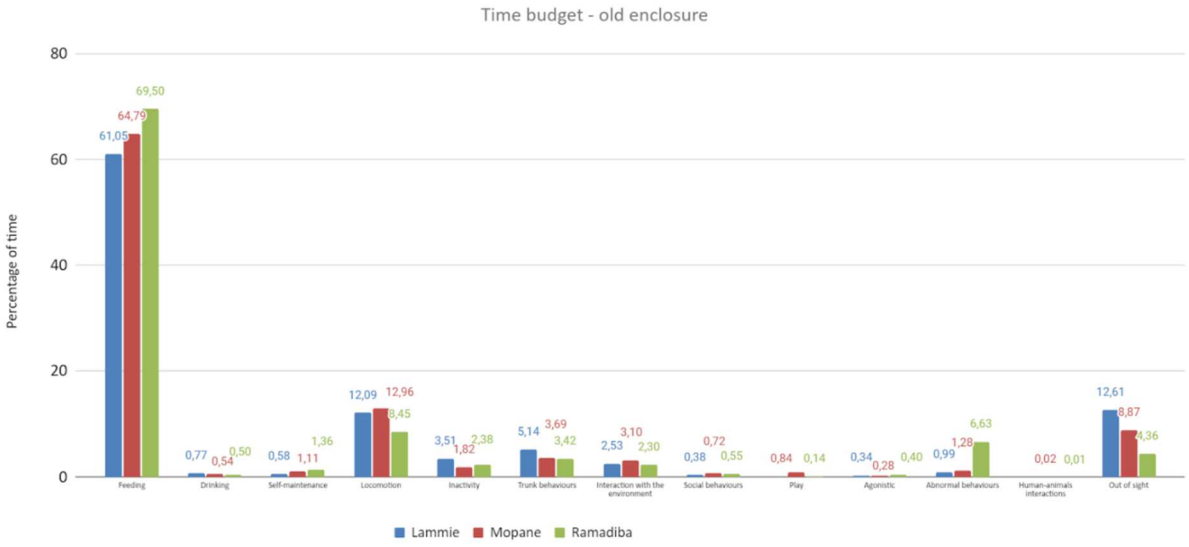


Figure 12. Bar chart showing the percentage of time allocated by each subject to behavioural categories in the old enclosure.

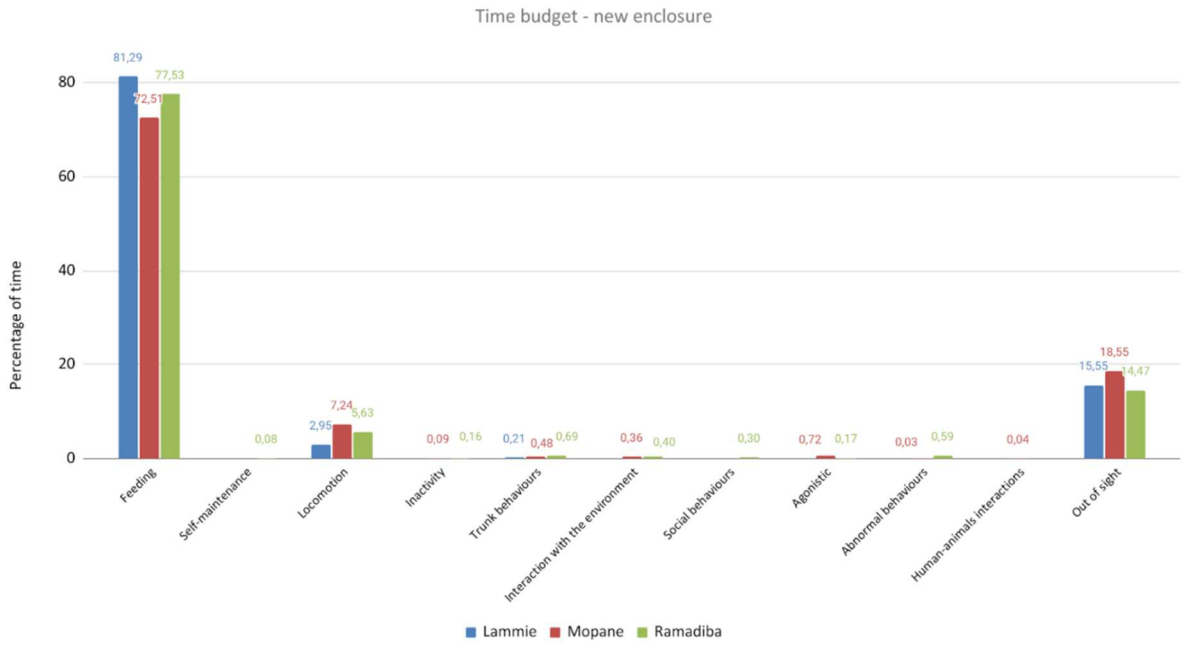


Figure 13. Bar chart showing the percentage of time allocated by each subject to behavioural categories in the new enclosure.

For the time budget in the night and bulk rooms (Figure 14 and 15), the analysis showed that feeding behaviours accounted on average for 82.02% of the subjects' time budgets in the bulk room and 42.25% in the night room. The mean percentage of out of sight was higher in the night room (51.22%) than in all the other sections (old enclosure, 8.61%; new enclosure, 16.19%; bulk room, 13.86%; boma, 16.81%). In both rooms trunk behaviours and locomotion were rarely performed, as for the remaining behaviours (*drinking, self-maintenance, inactivity, interaction with the environment, agonistic and abnormal behaviours*) that were almost never observed in the bulk room and seldomly in the night room.

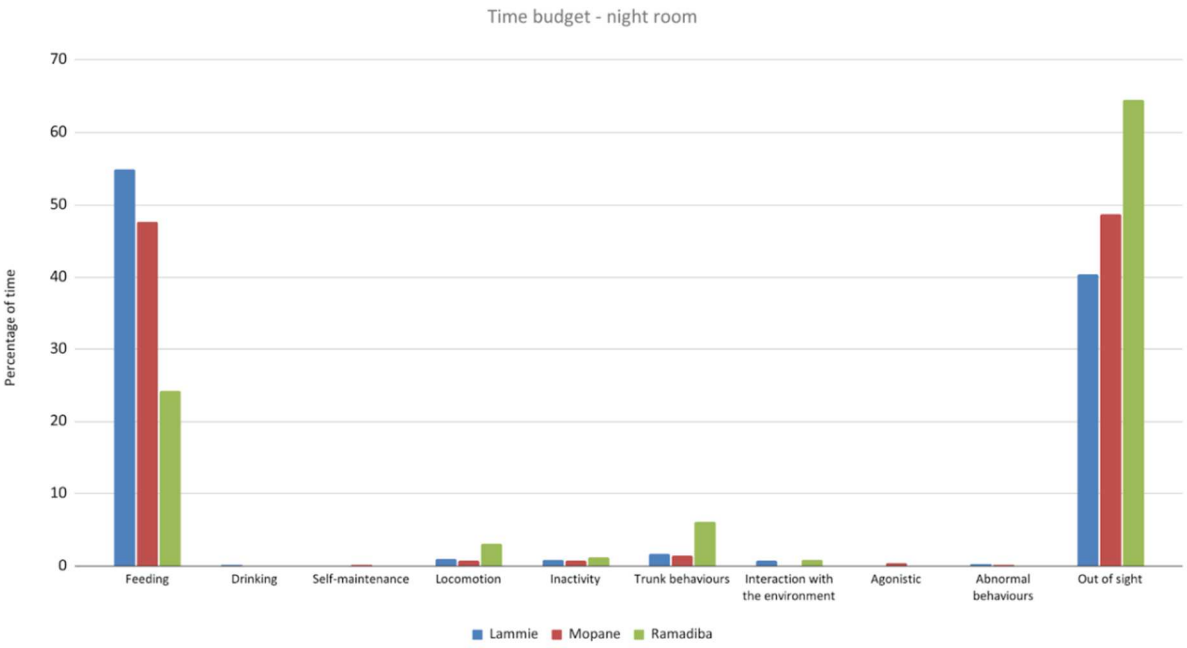


Figure 14. Bar chart showing the percentage of time allocated by each subject to behavioural categories in the night room.

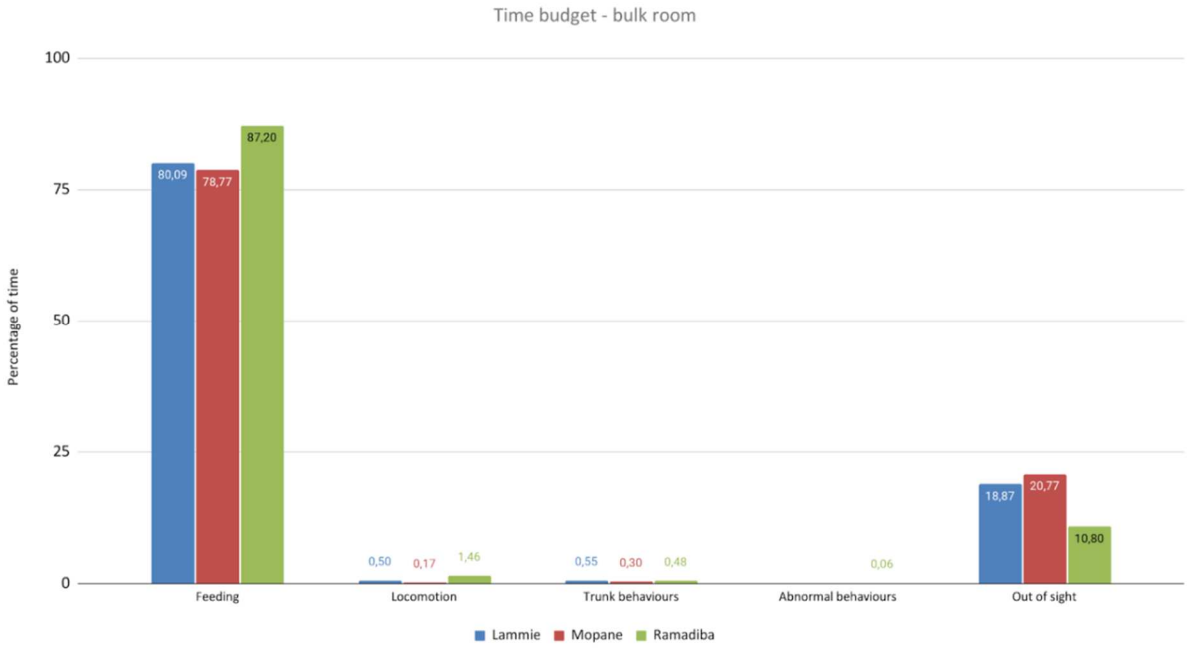


Figure 15. Bar chart showing the percentage of time allocated by each subject to behavioural categories in the bulk room.

As for the time budget in the boma (Figure 16), feeding accounted on average to 20.66% of time, and the other behavioural categories were performed more in the boma than in all the other sections, the mean time spent out of sight was 16.81%.

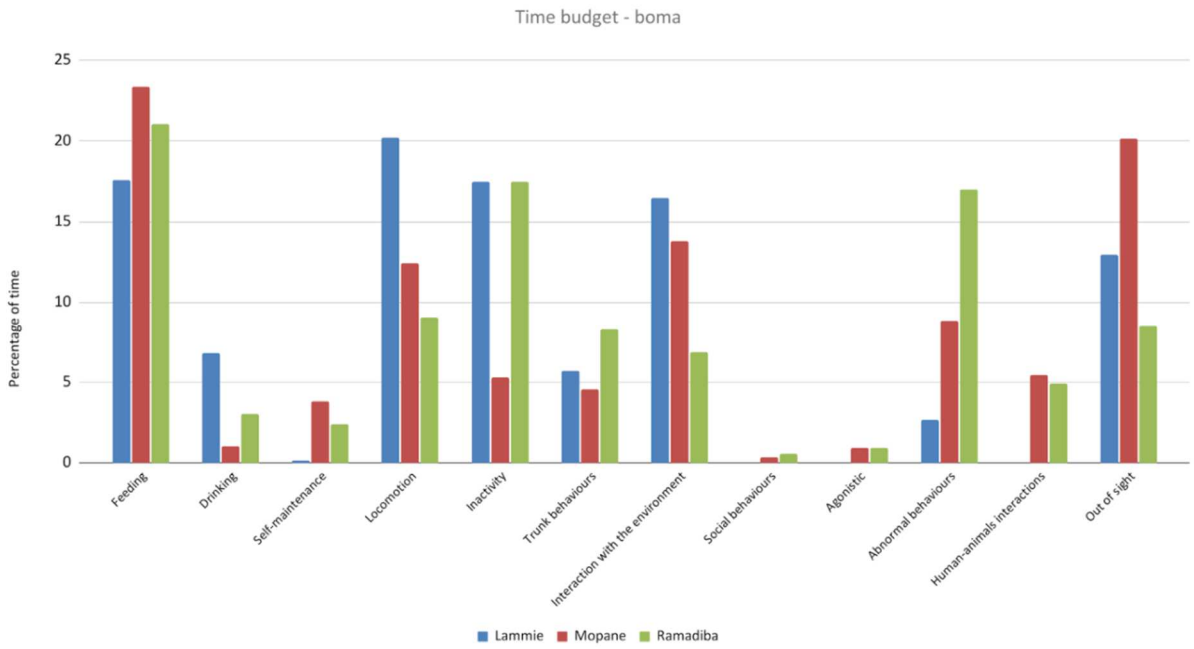


Figure 16. Bar chart showing the percentage of time allocated by each subject to behavioural categories in the boma.

6.3. Time spent in proximity or contact with conspecifics

Utilising the modifiers added during the analysis the proximity/contact percentage was calculated for each subject and compared with the time spent alone. As reported in Figure 17, the time spent alone by the subjects varies from 55.09% (Mopane) to 67.82% (Lammie).

On average, the time spent in proximity or contact with at least one of the other elephants was 37.93% (Lammie, 32.18%; Mopane, 44,91%; Ramadiba, 36.70%).

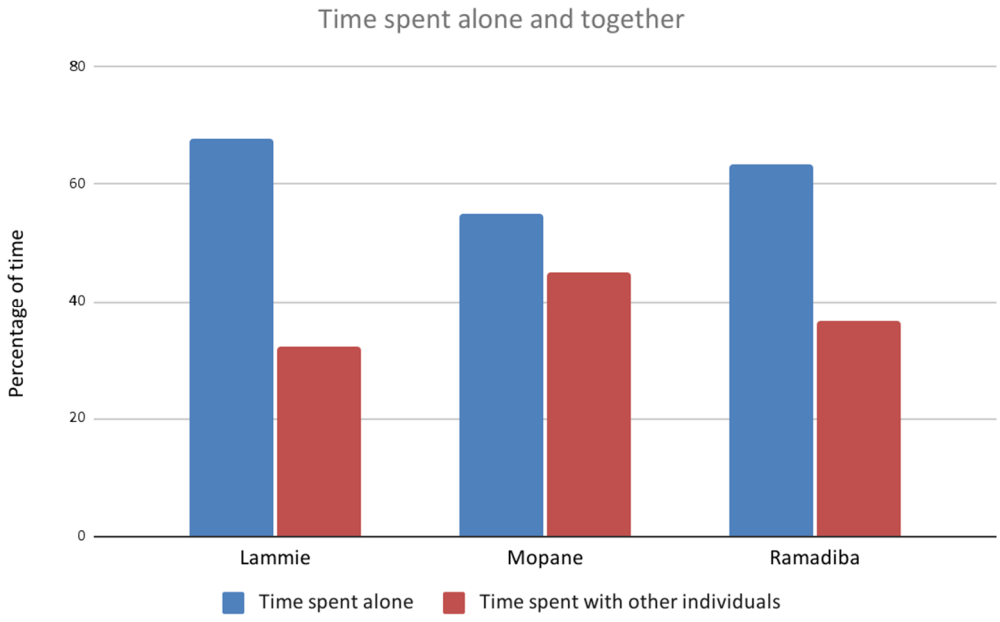


Figure 17. Bar chart showing the percentage of time spent by each subject alone and in proximity/contact with one or both the other individuals.

6.4. Event behaviours

During the observation period, a total of 1,512 point events (Table 4) were performed by the subjects. The most represented category was self-maintenance (Table 5) and the second was trunk behaviours. Most of the point events (186) were shown in the old enclosure, where the elephants spent most of their time, followed by the boma, where the amount of point behaviours was 78, as represented in Table 4. The only point behaviour performed in the bulk room belongs to Lammie. Of ten point events that occurred in the right room, one was performed by Ramadiba while the remaining ones by Lammie (self-maintenance (1); trunk behaviour (7); agonistic (1)). Mopane was not observed engaging in point events in both the rooms.

In Table 5, point events are listed according to which behavioural category they belong to and to the area they were performed by each subject. Human-animal interactions (HAI) and vocalisations were observed only in the old enclosure. Lammie engaged in one HAI, Mopane in 2 and Ramadiba in 3, regarding vocalisations both Ramadiba and Mopane performed 2 of them while Lammie was never observed vocalising.

Section	Lammie		Mopane		Ramadiba		Total	
	N.	%	N.	%	N.	%	N.	%
Old e.	186	67.15	729	91.93	355	80.32	1270	83.99
New e.	3	1.08	12	1.51	9	2.04	24	1.59
Boma	78	28.16	52	6.56	77	17.42	207	13.96
Bulk r.	1	0.36	0	0.00	0	0.00	1	0.07
Night r.	9	3.25	0	0.00	1	0.23	10	0.66

Table 4. Point events observed in each enclosure section for the three subjects. For each enclosure section the number and percentage of the point events recorded for each subject are reported.

	Old enclosure						New enclosure						Boma					
	Lammie		**Mopane**		**Ramadiba**		**Lammie**		**Mopane**		**Ramadiba**		**Lammie**		**Mopane**		**Ramadiba**	
Behav. categories	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Self-maintenance	94	33.94	603	80.08	166	42.31	2	0.72	10	1.26	3	0.68	25	9.03	22	2.77	17	3.85
Trunk behaviours	73	26.35	76	13.24	132	44.12	1	0.36	1	0.13	5	1.13	52	18.77	28	3.53	58	13.12
Agonistic	12	4.33	1	0.25	8	2.04	0	0.00	0	0.00	1	0.23	1	0.36	1	0.13	0	0.00
HAI	1	0.36	2	0.25	3	0.68	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Vocalizations	0	0.00	2	0.25	2	0.45	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Other	6	2.17	45	5.93	44	10.41	0	0.00	1	0.13	0	0.00	0	0.00	1	0.13	2	0.45

Table 5. Number and percentage of point events per behavioural category performed by each subject in the old enclosure, new enclosure and boma by each subject.

HAI = Human-Animal Interaction

7. DISCUSSION

The analysis of time budgets and behavioural repertoires is considered a valid mean for animal welfare assessment since it allows researchers to make comparison between zoo and wild elephants, monitor changes in relation to new environmental or social conditions, with a focus on positive welfare states (Veasey, 2006; Yon et al., 2019; Dawkins, 2003). Additionally, the occurrence of abnormal repetitive behaviours (ARBs), such as locomotor stereotypies, can be analysed to detect potential negative stimuli and evaluate the impact of environmental and social modification (e.g. changes in social structure, husbandry or enclosure) on welfare outcomes (Williams et al., 2018; Dawkins, 2003).

In the present study, the individuals allocated most of their time to feeding, secondly to locomotion and then to interaction with the environment, in accordance with previous studies conducted both in zoos and in the wild (Mackey, 2014; Horback et al., 2014). The percentage of inactivity and resting behaviours was lower compared to previous studies in controlled settings, being more consistent with the results obtained from studies on wild elephants that usually spend only 1.4% of their time budget resting (Wyatt and Eltringham, 1974). This could be also affected by the fact that it was possible to observe the individuals only during the day-light hours in the 24-h period, thus excluding night-time.

Variations in the location of food sources, representing unpredictability for a positive event (Basset and Buchanan-Smith, 2007) increased the time spent in environmental exploration, which was performed more than in previous studies (Mackey, 2014). Furthermore, the provision of branches as a time-consuming, naturalistic feeding enrichment increased foraging time, stimulated the performance of species-specific behaviours and constituted a critical dietary component (EAZA, 2020)

Abnormal repetitive behaviours were performed less than in other studies, where zoo-housed elephants usually showed a high performance of abnormal behaviours (Mason and Veasey, 2010). Future studies would be useful at assessing variations in ARBs over the 24-h period, on the long term and across seasons (Brando and Buchanan-Smith, 2017).

A higher performance of different behavioural categories was observed in the boma, but with a reduction of time dedicated to feeding and an increased percentage of ARBs. A possible cause of this is the space limitation and the provision of a unique food-source. The supply of diverse, time-consuming food sources as well as enrichments could help increase food-related behaviours, environmental interaction and reduce the occurrence of stereotypies (Williams et al., 2018; EAZA, 2020),

Elephants, being highly social animals, are positively affected by having the freedom of choice of social partners (Brando and Buchanan-Smith, 2018; Williams et al., 2018). Social complexity and compatible conspecifics buffer stress and enhance social interactions (Brando and Buchanan-Smith,

2018). The three individuals spent more time alone rather than in group, but more than 30% of the observation time was spent in the same area, in proximity or in contact (Mopane spent almost half of her time with a conspecific). Furthermore, agonistic behaviours were rarely observed, indicating the absence of competition among the individuals for space and resources. This general picture suggests that the three conspecifics are compatible and probably enhance the welfare of the others.

The three subjects had free access to the old enclosure and the night room for most of the time and could choose where to go, also in the other enclosure sections according to management schedules. To date, little is known about how far elephants should walk under human-care, but researchers suggest that unpredictable feeding schedule, both in time and space, should be performed in order to increase locomotion, food-related behaviours and investigation, thus reducing ARB occurrence (Basset and Buchanan-Smith, 2007). The employment of an unpredictable temporal and spatial feeding schedule would be beneficial to the animals, increasing positive behaviour displays, as investigation, and feeding-foraging time.

Human-animal interactions were limited and mainly occurred in the old enclosure around cleaning time. HAIs consisted in walking toward a call three times for Ramadiba and twice for Lammie, then three times Ramadiba took something from a person while Lammie just once. No one of the individuals was observed throwing objects at someone and Mopane was never observed interacting with people. HAIs are an important welfare aspect, but they will need further research.

The amount of time where the individuals were out of sight was higher in the night room, probably due to the observer's necessity to change the recording position and due to the fact that the observation spot in the room was a small window on a closed door.

The dry moat surrounding the old enclosure can be an issue for the elephants, who have been recorded multiple times trying to reach grass on the other side of it. Concrete, hard surfaces should be avoided and particularly dry moats should not be present in an enclosure where animals spend most of their time permanently (EAZA, 2020). Concrete surfaces should be replaced with softer and diverse substrates in the different enclosure sections to prevent foot/toenail problems and enhance exploration behaviour.

For the present study observations were limited to three days and animals could not be recorded at night, due to the absence of lights and internal cameras in the night room. Environmental factors, such as temperature and noise level, were not recorded during the three-days period, thus future focus will be aimed at assessing the effect of environmental and human-related factors on the subject’s behaviour. The project will monitor the elephants’ welfare over the long-term, based on the first insight this study provided, and will also investigate how behaviour and enclosure use change throughout the day.

8. CONCLUSION

This preliminary study aimed to obtain a first insight into the welfare state of the three African elephants housed at the Johannesburg zoo. After the observation of ethological parameters over three days, the time budgets and the behavioural displays of the individuals were investigated. This provided information on the most performed behavioral categories, time spent in the same area or proximity or contact with conspecifics, and punctual events of the three animals. The results identified potential welfare issues and laid the groundwork for future data collection and research to evaluate elephant long-term welfare, also focusing on environmental and human-related factors, as well as variations in use of the enclosure along the day.

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11. APPENDICES

Appendix A

Table 2. Elephant working ethogram, adapted from Poole and Granli (2011), Jeffrey (2017), Yon et al. (2019), Pollastri et al. (2021), and Poole and Granli (2021). Asterisks represent behaviours classified as 'events' (Altman, 1974; Martin and Bateson, 2007).

African Elephant - Working Ethogram	
Name	**Definition**
Other*	Performing a behaviour not listed in the ethogram
Out of sight	Animal is not visible, partially, or completely
Not recording	The observer is moving from one position to another or has any kind of problem that inhibits to observe the animal due to technical issue.
Interaction with the environment	
Digging	Kicking or scraping dust with feet or dirt backward/behind the elephant. May also occur as an aggressive behaviour, or prior to engaging in *Lying*.
Tusking in the ground	Digging with tusks into ground, or rubbing of tusks on logs
Alert	The animal stops what is doing and turn the body toward a specific stimulus (keeper, sounds, visitors, observers, other animals) while standing still, it may swing the trunk around
Object manipulation	The animal uses its trunk to pick up a small not-edible object to examine it. The small object could be taken to the mouth, placed into the mouth or dropped.
Investigation	The animal moves its trunk in front of himself or around the body, limiting locomotion and probably sniffing the environment.
Bring to mouth inanimate object	The animal brings to mouth, chew and spit out an object.
Feeding/ Foraging/Drinking	
Drinking	Using trunk to take water and put it into the mouth.

Feeding and Foraging	Holding a bunch of teff grass/hay in the trunk putting food in the mouth with the trunk. Actively searching for food with the trunk
Trunk behaviours	
Trunk-body part*	Touching a specific part of the own body with the trunk.
Trunk on head	Placing and holding the trunk for at least 5 seconds on own head
Trunk forward	Trunk extended outwards toward an object, other animals, keeper, observers, visitors (please specify).
Trunk swirling	Animal swirls downwards its trunk's first half, second half or both on its circular axis
Trunk up	Animal swirls its trunk as before but upwards
Trunk in mid air	Holding the trunk in a way that is not completely bent nor extended but with no apparent aim
Inactivity	
Standing	Standing motionless with trunk on the ground or on the fence, eyes open or closed (it may include maintenance behaviours, it may move the tail, ears, yawn).
Lying	Lying down with eyes open or closed (it may include maintenance behaviours, it may move the tail, ears, yawn).

Locomotion	
Walking	Animal takes more than 2 steps forward, but not in a stereotypic pattern.
Walking backwards	Animal takes more than 2 steps backwards, but not in a stereotypic pattern.
Run	A faster paced version of walking; more than one foot is removed from the ground at any one time.
Walking and trunk forward	Walking while performing trunk forward

Walking and trunk curled of trunk	Walking while performing trunk curled of trunk
Walking and trunk on head	Walking while performing trunk on head
Walking and trunk in mid air	Walking while performing trunk in mid air
Walking and trunk over face	Walking while performing trunk over face
Walking and trunk up	Walking while performing trunk up
Spin	Move in place, keeping either the forelegs or hindquarters still
Self-maintenance	
Body slap*	Hitting of own body with tail or trunk, appears to be a means of removing an insect or other irritant.
Yawn*	Opening the mouth wide to take in air, eyes can be open or closed
Defecate urinate*	Defecate urinate
Trunk in mouth	Holding trunk in own mouth for at least two seconds - a behaviour frequently seen in young elephants
Ear flap*	Moving one or both ears
Bathe	Standing or lying in water up to the depth of the belly or deeper
Rubbing	An elephant presses/scrubs its (flank/hind part/head/legs/...) against (trees/fences/walls/etc)
Scratch body	Repetitive self-touching of the body with trunk or foot[2]
Scratching with tool	Scratching the body with a tool, e.g. branch or stick

Head shaking*	Rapid movement of the head from side to side
Mud bathing	Roll, lay down, wallow or move about in an area that is (wet/muddy/sandy/dirty)
Water bath	Collecting water with the trunk and spraying it on the body
Throwing	Putting or blowing objects on own body. Please specify: grass, straw, sand
Spray*	Spraying material from trunk
Play	
Locomotor play	Intense motor activity performed in a persistent and frenetic way.
Playing with a water source	Rolling around within a body of water or manipulating a water source with the trunk in an intense and frenetic way
Social play	Playing with an elephant: Engaging in active play with another elephant, including head to head sparring, trunk wrestling, mounting, chasing, and rolling on one another. Does not include behaviours observed following an antagonistic encounter or as part of courtship.
Object play	Using body parts to manipulate/interact with inanimate items or food to create unpredictable situations.

Social behaviours	
Affiliative touch (not with trunk)	Leaning on another, rubbing body against other, nudge other elephant, sit or stand on other
Trunk-mouth	Putting the trunk in the mouth of another elephant
Follow	One elephant walks closely behind (within 2 elephant body lengths) of another elephant

Affiliative touch (with trunk)	Placing the trunk on the body of another elephant (touching any area other, tail of other)
Parallel walk	Two elephants walking side by side, for 3 or more steps
Back toward	Elephant turns to present posterior and walk slowly backwards into another individual
Tail	Holding the tail of another elephant with the trunk or underneath a leg
Trunk-trunk	Intertwining of trunks between two elephants
Approach	Walking to another elephant and then stays in close proximity (a distance up to one body length between individuals). There is no influence of any other stimulus (e.g. feeding or a human factor)
Presenting	Turn bum towards another's front end and back into them (sexual behaviour usually performed by a female to male)
Climb	Placing at least one foot on top of another elephant - usually one that is lying down
Offer food*	One elephant uses a part of its body to push food towards another elephant
Share object	Simultaneously handling with the trunk an object with one or more conspecifics
Agonistic	
Tusking	Poking or jabbing at another elephant with the tusk.
Charge	Move towards another elephant with the head held high, pace usually quickens as an individual gets closer to the target elephant, can lead to pursuit of another elephant.
Bite*	Biting of the body, trunk or tail of another elephant.

Kick*	Strike out or hit an elephant or object with a foot - note object may include enclosure bars or kicking of sand towards another elephant.	Modifier: toward - Mopane - Ramadiba - Lammie
Push	Forcing or pressing against the body (usually the rump) of another elephant, resulting in the elephant that is MOVED for at least two steps.	Modifier: toward - Mopane - Ramadiba - Lammie
Stand off	Two elephants standing facing in opposite directions with foreheads pushing against each other.	Modifier: with who - Mopane - Ramadiba - Lammie
Smack*	Hitting the trunk on the floor, may be accompanied by a 'snort'.	
Avoidance	Turns head, rump or whole body away from the particular elephant or observer/tourist/zookeeper, it may be followed by walking away	Modifier: toward - Mopane - Ramadiba - Lammie - Observer - Tourist - Keeper/ staff - Other animal
Food stealing*	Taking food from another elephant individual either walks forwards away from or backwards away from a particular elephant	Modifier: toward - Mopane - Ramadiba - Lammie
Aggressive display: standing	Facing another elephant in an aggressive posture; head held high, ears wide or flapping.	Modifier: toward - Mopane - Ramadiba - Lammie
Aggressive display: walking	Display of dominance while walking; head bobbing up and down or side to side, ears wide or flapping.	Modifier: toward - Mopane - Ramadiba - Lammie
Redirected aggression	During a conflict situation an individual may redirect their aggression onto another elephant, observer/tourist/zookeeper or object, e.g. uprooting trees or throwing objects.	Modifier: toward - Mopane - Ramadiba - Lammie - Object - Observer - Tourist - Keeper/ staff - Other animal

Size up	Two elephants directly facing each other, heads raised and ears spread wide.	Modifier: with who - Mopane - Ramadiba - Lammie
Intervening	An elephant places its body between the aggressor and the target (i.e. 'protecting' the target elephant from the attack).	
Chase	Running in pursuit of another elephant.	Modifier: toward - Mopane - Ramadiba - Lammie
Head contact	Head to head with another elephant.	Modifier: toward - Mopane - Ramadiba - Lammie
Strike*	Hitting another elephant or observer/tourist/zookeeper with the trunk or tail.	Modifier: toward - Mopane - Ramadiba - Lammie - Object - Observer - Tourist - Keeper/ staff - Other animal
Abnormal behaviours		
Feeding On Sand	Eating sand/substrate	
Trunk over face	Trunk tip curled forward and pulling trunk down over face	
Trunk curled of trunk	Trunk tip curled forward and pulling trunk down over trunk	Could be normal, physiologic
Trunk swing	Moving the trunk from side to side or forward and backwards in a repetitive manner	
Lift leg	Standing still repeatedly lifting one foot in the air	
Self-Aggressive Behaviours	Suckling own body parts, excluding trunk suckling	
Trunk sucking	Sucking or chewing one's own trunk. Does not include resting the trunk in the mouth.	

Bar biting	Chewing or gnawing on enclosure bars.	
Head bob	Bobbing head up and down in a repetitive manner	
Leg swing	Standing still repeatedly swinging one front leg back and forth.	
Pacing	Animal takes steps forward or backwards in an unvarying, repetitive manner, considering pacing after the repetitive fifth step forward/backwards.	
Rocking	Repetitive movement of the body back-and-forth transferring weight from hind to front leg.	
Tusk banging	Repetitive hitting or rubbing of the tusks on objects (e.g. enclosure bars or logs).	
Swaying/ Weaving	Repetitive movement of the body side-to-side and/or back-and-forth.	
Throwing faeces	Tossing faecal material into air or on self.	
Bring to mouth inanimate object	The animal brings to mouth, chew and spit out an object.	Specify in the comment which object
Vocalizations		
Trumpet*	Loud high-pitched trumpeting sound from the trunk	
Rumble*	Low amplitude vocal rumbling noise from the trunk or mouth	
Other vocalizations*	Making noises in the human auditory receptive region	
Human-animals interactions		
Walk toward call	Walk towards tourist/zookeeper when called	Modifier: toward - Tourist - Observer - Keeper/staff - Other
Taking from*	Taking food/object offered by tourist/zookeeper directly from his/her hands	Modifier: object - Food

		- Object - Other Modifier: giver - Tourist - Keeper - Other
Throwing objects	Throwing food/object towards observer/tourist/zookeeper	Modifier: object - Food - Branch - Object - Other Modifier: toward - Observer - Tourist - Keeper/ staff - Other