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Nocturnal Activity Budget of Captive Bred Sand Cat Kittens During Weaning Period

KimJohn S. Doble, Demi C. Booth

Department of Zoology, Dubai Safari Park, Dubai, United Arab Emirates.

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ABSTRACT

The sand cat (*Felis margarita*) is a specialist of arid desert habitat, with a wide but patchy distribution in North Africa, the Arabian Peninsula, Iran, Central Asia and Pakistan. Due to its small size, perfect camouflage and its nocturnal habits; the sand cat is not an easy species to observe in the wild and little is known about their nocturnal behaviour. Diurnal time-activity budgets are commonly performed in captive animal collections, but little consideration is given to how animals behave outside of zoo opening hours. The assessment of nocturnal behaviour can provide more detailed information on how animals use the space provided to them and shed light on behaviour not commonly observed. This study examined the nocturnal behaviour and activity of 1.2 captive bred sand cat kittens during weaning period. Observations were conducted from July to August 2019 at Dubai Safari Park in United Arab Emirates. Nocturnal observations were recorded from 19:00 until 06:00 hours using a camera trap. A scan sampling data collection technique was used to find the percentage of time spent by each cat in each behaviour. A total of 15 behaviours were observed from 1,578 behaviour samples recorded. Observations show that the most active behaviours of the kittens were recorded as 'Alert' behaviour (28%), locomotion (25%), and socializing (16.5%). It was observed that the kittens were most active between 01:00 to 06:00 hours. It is recommended that further studies are needed with the use of Close Circuit Television (CCTV) Camera that can run 24-hours to account for any diurnal activity leading up to sunset prior to study timeframe that starts from 19:00 and ends to 06:00 hours, and to gather adequate information and to obtain more detailed results.

Corresponding Author: KimJohn S. Doble

Email: kim_doble@yahoo.com

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INTRODUCTION

Species background

Status in the wild

Due to its small size, perfect camouflage and its nocturnal habits; the Sand cat (*Felis margarita*) is not an easy species to observe in the wild. The habitat of this species is remote and harsh for humans and most sand cats are present in countries where much political instability occurs and access to wildlife scientist is limited. Consequently, there is no current accurate information of the species number. Leading scientists have estimated

that the sand cat population size should not exceed 10,000 individuals with no subpopulation having an effective size above 1,000 (Mallon and Budd, 2011).

The sand cat is classified in the category 'Near Threatened' in the IUCN Red List since 2002 and this status was reassessed and reconfirmed in 2011 (Mallon, et al., 2011). The species was previously classified in the categories 'Lower risk/Least Concern' and 'Insufficiently Known' (Bretton, 2013).

Morphological Features

The Sand cat is the smallest of all wild cats, with males

weighing between 2.1-3.4 kg and females weighing between 1.4-3.1 kg (Smithsonian's National Zoo and Biology Institute, 2020). Their most distinctive characteristic is their large ear pinnae, which protect the ears from blowing sand. Sand cats have a pale sandy to grey-brown coat, which is slightly darker on the back and pale on the belly, with occasional stripes on the legs. Bold, red streaks run across each cheek from the corner of both eyes. Sand cats have a broad head with large eyes and low-set ears. They have short limbs. The tail, which can account for about half of the head-body length or 28-38cm (Ghadirian et al, 2016), features two or three rings and a black tip. Sand cats have dense hair and pads on the soles of their feet that protect against the intense heat and cold of their habitat, as well as aiding in movement across the sand. The pads help them navigate across shifting sands (Smithsonian's National Zoo and Biology Institute, 2020).

Reproduction

Reproduction among sand cats depends on where they live and the range in time of year chosen for breeding is believed to be a result of either climate or available resources. Individuals from the Sahara will begin breeding in January and end in April. Those occurring in Turkmenistan will begin breeding in April, and in Pakistan the season will last from September to October. In human care, this species can breed more than once a year. Gestation for sand cats lasts 59 to 67 days, and females give birth to a litter of one to eight kittens, although two to four is most common. Kittens weigh just

over 39 grams at birth. Juveniles become independent by 6 to 8 months old and will be sexually mature by 14 months (Smithsonian's National Zoo and Biology Institute, 2020).

Habitat and distribution

The Sand Cat is a specialist of arid desert habitat, where it is unevenly distributed, localized around sparse vegetation which can support small rodent prey (Novell and Jackson 1996). The Sand Cat is the only felid found primarily in true desert. This species has a wide (Estimated: 15,414,561 km²) but disjunct distribution in the deserts of northern Africa and southwest and central Asia (Figure 2) Home range sizes will likely vary according to ecological conditions and vegetation availability for prey animals, likely more favourable in suitable habitat of protected areas, where there is no major disturbance through domestic stock grazing (Silwa, et al, 2016). It is not clear whether the gaps in known range are due to a lack of records or truly reflect species absence (Hemmer et al. 1976, Nowell and Jackson 1996). Sightings have been reported in Libya and Egypt west of the Nile (Sliwa, et al, 2013), but there are no confirmed historical records despite intensive collecting effort in this part of the Sahara (Hemmer et al. 1976) and this is unchanged to present. The population trend of the sand cat is decreasing however this species is classified as LC - Least Concern. Threats to this species include residential and commercial development, agriculture, biological resource use, climate change and invasive species (Silwa, et al, 2016).

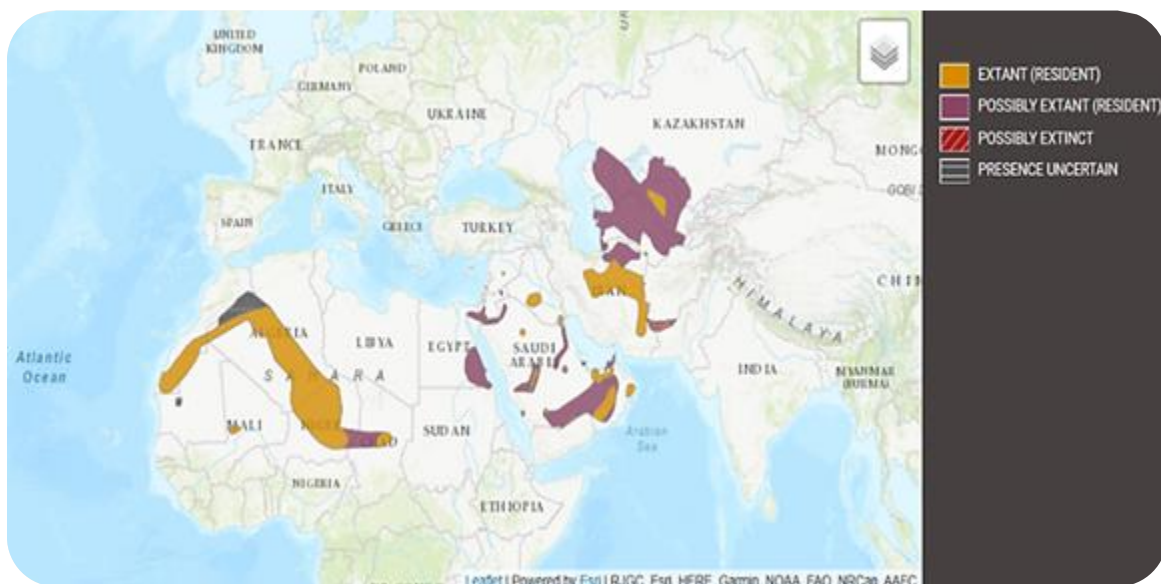


Figure 1. The distribution of the Sand cat *Felis margarita*. (Silwa, et al, 2016).

Behaviour in the wild

Sand cats prefer a very dry, arid habitat with little vegetation, for which they are well adapted. They are sand-dwelling creatures, inhabiting dry plains and rocky valleys where conditions are extreme (Smithsonian's National Zoo and Biology Institute, 2020). Surface temperatures can reach 51 degrees Celsius during the daytime, then drop to as low as -0.5 degrees Celsius at night. This species prefers flat or rolling terrains and will retreat to burrows when temperatures become too extreme. Due to the importance of burrowing and digging to sand cats, they are not found in areas where soil is compacted.

The most highly developed senses of this species are hearing and smelling. Being nocturnal and crepuscular animals, they rely on sensitive hearing to locate prey moving below the surface of the ground. Sand cats avoid the intense heat of the desert by hiding in burrows, relying on their ability to dig to create shelter from extreme weather.

The diet of wild sand cats is comprised mainly of small rodents as is its primary prey, with records including Spiny Mice *Acomys spp.*, Jirds *Meriones spp.*, Gerbils *Gerbillus spp.*, and Jerboas *Jaculus spp.* and *Allactaga tetradactyla*, but also young of Cape Hare *Lepus capensis* in Africa. It has also been observed to hunt small birds like Greater Hoopoe Lark *Alaemon alaudipes*, Desert Lark *Ammomanes deserti*, and to consume reptiles such as smaller Desert Monitor *Varanus griseus*, Fringe-toed lizards *Acanthodactylus spp.*, Sandfish *Scincus scincus*, Short-fingered Gecko *Stenodactylus spp.*, Horned and Sand vipers of the genus *Cerastes*, and insects (De Smet 1989, Abbadi 1993, Dragesco-Joffé 1993, Cunningham 2002, Sliwa et al, 2013). Sand cats hunt by skulking close to the ground and using their enhanced sense of hearing to detect prey. Sounds of a potential meal burrowing underneath the ground trigger sand cats to begin digging rapidly to expose and capture prey. Upon capture, they may cover its kill and return later to feed (Smithsonian's National Zoo and Biology Institute, 2020).

Importance of research in nocturnal animal behaviour in zoos

Diurnal time-activity budgets are commonly performed in captive animal collections, but little consideration is given to how animals behave outside of zoo opening hours (Rose and Croft, 2018). The assessment of nocturnal behaviour can provide more detailed information on how animals use the space provided to

them and highlight how enclosure areas not commonly occupied during the day may still be important for inhabitants at other times, as well as exploring enclosure use and activity budgets, nocturnal studies can shed light on behaviour not commonly observed. The sand cat is a solitary species and not much is known about its nocturnal behaviour. It has been reported that wild sand cats will close their eyes to avoid 'eye shine' thus making it difficult for researchers to observe their nocturnal behaviour, therefore, it is imperative that any opportunity is taken to further understand the behaviour of the species under human care.

STUDY AIMS

The goal of this research is to investigate the nocturnal behaviour of sand cat kittens during weaning period. This research aims to know the activity budget of the animals' activity and to classify the animals' most active time from a given timeframe.

METHODS

Study site

This study was carried out at Dubai Safari Park, Al Warqa'a 5, Dubai, United Arab Emirates. As the planned nocturnal habitat is not yet finished, the studied animals were housed in a temporary off-show exhibit with an area of 4 square meters surrounded by concrete walls and heavy-duty material meshing. The enclosure is also located beside the temporary enclosures of other small carnivore species (e.g., Fennec Foxes (*Vulpes zerda*), Ferrets (*Mustela furo*) and Spotted Genet (*Genetta genetta*)), with some visual barriers in between enclosures.

Provision of enrichments, and furnishings such as feeding bowls, hollow tree trunk, logs, nest boxes, substrates, scratching poles novel objects such as ball pits and tree branches (with leaves) were offered at the setting.

Animal history

Three Sand cat kittens, sex ration 1.2, were born in Safari Park Dubai on 8 March 2019 (Fig. 3). Prior to the study, physical and behavioural observations were assessed daily to monitor the growth progress of the kittens. They started opening their eyes on the 20th day and started roaming around the enclosure and eating solid food a month after birth. The kittens were removed from their mother for weaning at 4 months and 18 days of age. The parents of the kittens were donated to Dubai Safari from a private collection in Syria, however there was no

background history provided. The kittens were born before the start of summer season in UAE. The diet of the sand cats at Dubai Safari Park is composed

of fuzzy mice, dressed quail and red meat, carnivore pellets were occasionally used as food-based enrichment. During weaning, the diet of the species was not altered.



Figure 2. Three days old 1.2 Sand Cat kittens with their mother.

Procedures

Data were collected between 27 July to 23 August 2019. The nocturnal activities of 1.2 sand cat kittens were recorded using a camera trap from 19:00 hours to 06:00 hours. The video camera was used to record the behaviour of the animals inside the den to ensure that it was not influenced by the presence of a keeper. The behaviour of the kittens was recorded every 30 seconds, using the instantaneous sampling technique. An activity time budget (%) was calculated for the animals using the frequency of behaviours performed. An Ethogram of behaviours (Table 1) was developed and used to define each behaviour recorded during observations.

Table 1. Ethogram of behaviours.

Behaviour	Description
Sniffing	Animal stroking olfactory glands to an object.
Eating/Drinking	Animals are consuming food or water.
Self-Grooming	The animal's practice in cleaning itself by means of licking.
Socializing	The animals' action of participating in social activities of the other individual (e.g., playing, chasing, grooming and fighting).
Scratching	Animal's action to scratch only any surface of the enclosure or an object. This include scratching a log or a scratching pole.
Furnishing or enrichment interaction	Any behaviour that shows interacting with furnishing such as biting or nibbling leaves, hays, or ropes. This behaviour excludes scratching behaviour.
Defecating/Urinating	The animal is discharging urine and faeces.
Digging/Burying	the animal shows behaviour of digging a substrate or covering food or urine/faeces.
Locomotion	The animal shows movement from one place to another in a given speed (e.g., walking and running). Chasing and stalking are EXCLUDED from this behaviour.
Jumping	The animal's ability to transfer location from lower places to a higher place or vice versa.

Climbing	Animals are moving to a higher position (ascending) or to a lower position (descending). Example climbing up or down the mesh.
Vocalizing	The animal is producing a sound using vocal organs.
Hunting	The animals are showing hunting behaviour such as hunting stance and in preparation to pounce kind of behaviour. Stalking is also included in this behaviour.
Alert	this behaviour shows the animal is observing its surroundings by means of moving its head, alert and not moving any position. Laying active.
Stationary, Resting, Laying	The animal is not moving, no signs of movement or is in a resting position. Laying passive. Sleeping

RESULTS

Throughout the study period, a total of 11 trap nights (from 19:00 to 06:00) were obtained from a total of 15 days random sampling. During the time, 1,578 activities from 15 different behaviours were accumulated and a total of 553 minutes of activity time were recorded.

Activity budget

Results show that the highest percentage of time spent by the animals was performing alert behaviour (28%), followed by locomotion (25%), socializing (16.54%) and stationary, resting and lying with 10.77%. The rest of the behaviours were below 3% of their nocturnal activities.

Maintenance, Active and Inactive Behaviours

The study animals displayed a total of 5 percent of their nocturnal activity budget performing maintenance behaviours (Eating/Drinking-2.28%, Self-grooming-

2.72%). A total of 84% of the animals' time was spent performing active behaviours (Sniffing- 3.23%, Socializing- 16.54%, Locomotion- 25.03%, Climbing- 1.46%, Jumping- 2.53%, Hunting- 2.92%, Digging/Burying- 0.95%, Scratching- 1.77%, Vocalizing- 0.06%, Alert- 28.01%, enrichment interaction- 2.03%), and 11% of their activities were recorded as inactive.

Hourly Activity Budget

The hourly activity expenditure (in percent) of the animals over the entire study period. The animals' nocturnal movements were mostly observed between 01:00 to 06:00 hours and at 19:00 hours, where major behavioural activities reach its peak from 10-18%. Between 1-4% of their activities were observed from 20:00-12:00 hours (Figure 5).

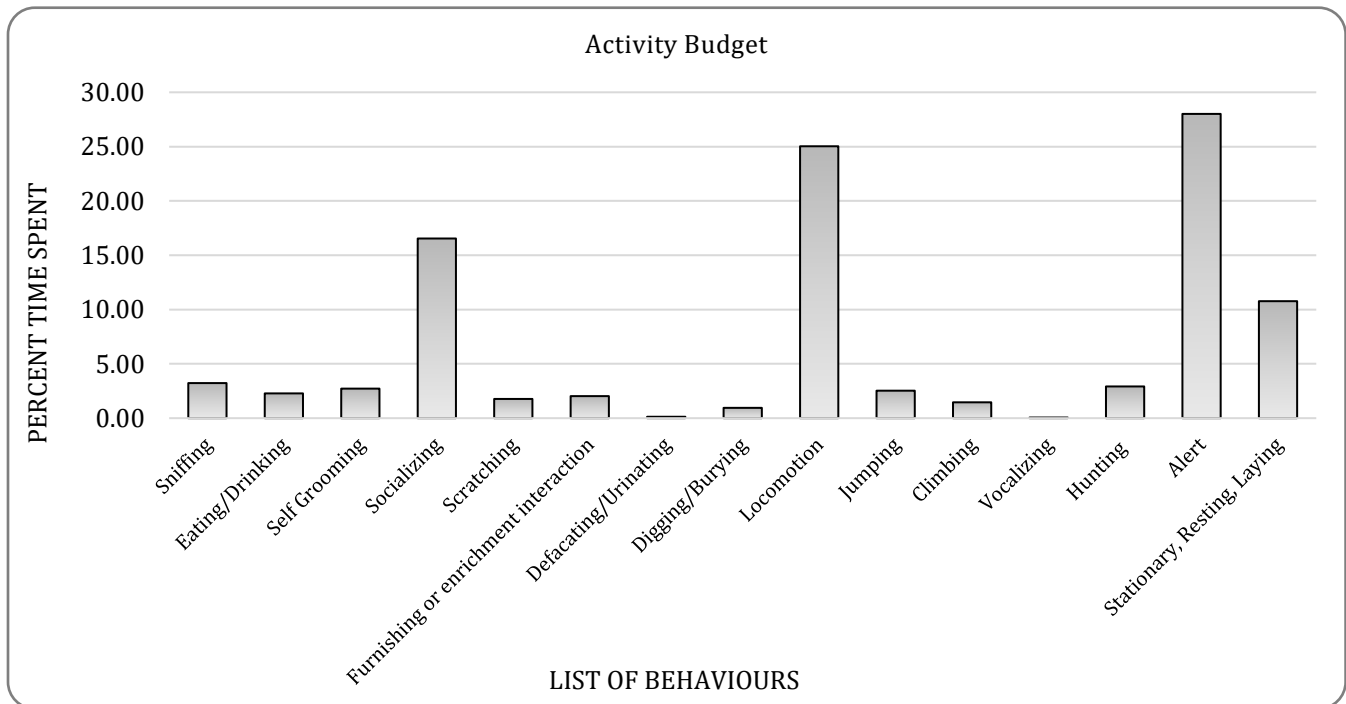


Figure 3. Percent Activity Budget.

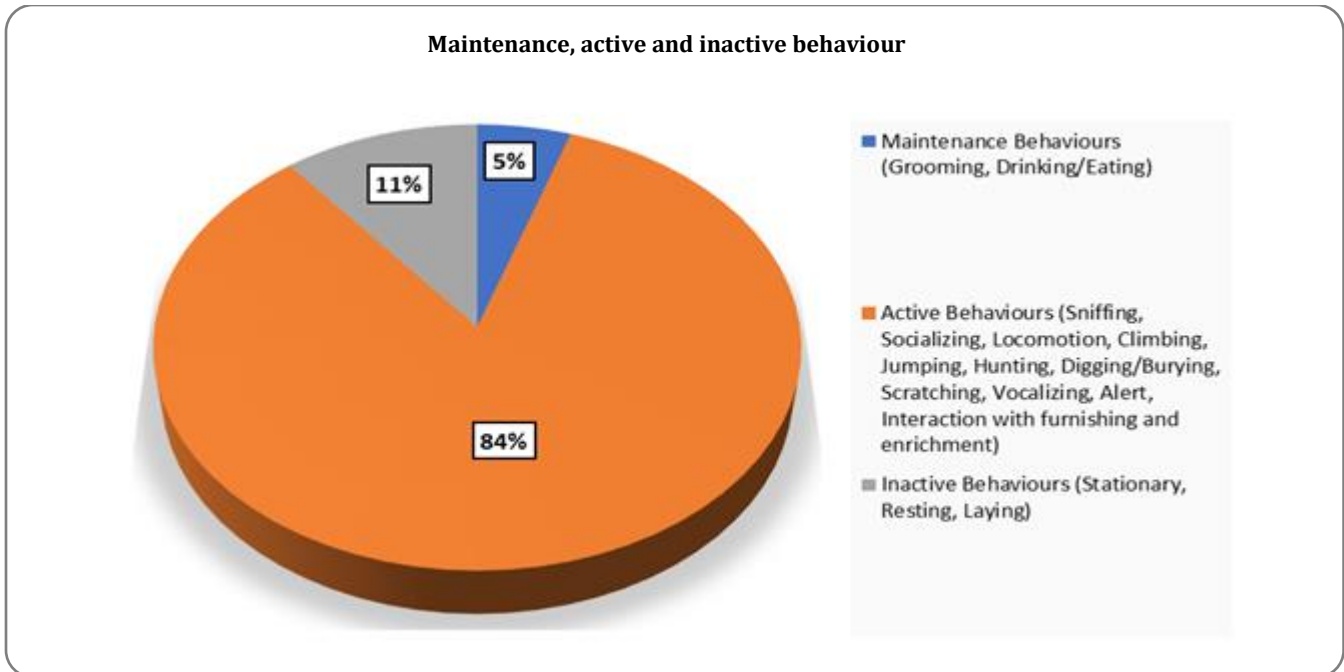


Figure 4. Maintenance, active and inactive behaviours.

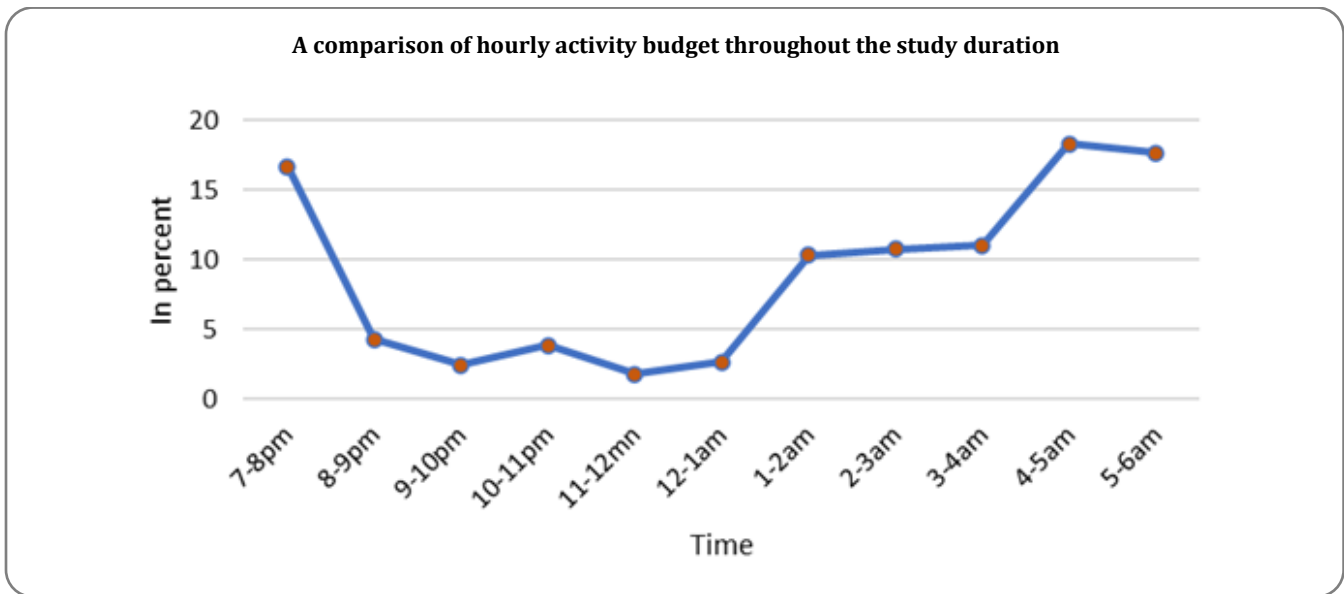


Figure 5. Hourly Activity Budget Chart

DISCUSSION

Implications for conservation

It is evident from the lack of research that the sand cat has been neglected in terms of captive behavioural management. As a rare and a lesser charismatic species than its well-known cousins (e.g., big cat species such as tigers (*Panthera tigris*) and lions (*Panthera leo*)), a larger effort should be made to understand the behaviour of this

secretive species and how best to encourage a natural behavioural repertoire of specific behaviours and manage the prevalence of undesirable behaviours in captivity, as the persistence of these behaviours may have negative implications for the future release of captive animals as a conservation strategy.

How does this research benefit keepers?

Addressing the physical and psychological needs of the

animals in their care is important for all zoological institutions to optimize the welfare of the species (Mellor *et al.*, 2015). Behavioral research is an important process that can assist keepers to provide appropriate standards of care for their animals and can be an efficient way to ensure that they are in optimal welfare conditions. Carrying out behavioral research in a zoological environment makes it possible to assess specific aspects of an animal's daily routine and when the results are analyzed in detail, it should be possible to identify problem areas in the husbandry regime. The results of this behavioral research will provide evidence to support alterations in enclosure design and husbandry methods and make it possible to evaluate the effectiveness of any changes that are made.

While there is limited research regarding the behavior of small felids and sand cats in particular; the few that have been published pertain to diurnal behavior. Mellen (1993) conducted a comparative analysis of scent-marking, social and reproductive behaviour in 20 small felid species housed in zoos and found that while small felids vary widely in their habitats and the prey items they consume, they are remarkably similar with regard to the behavioural mechanisms they use to communicate with conspecifics. While the frequency of social behaviours differed between species in this study, it was noted that the appearance of these behaviours was similar (e.g. grooming, play); which may help with the development of a felid ethogram however, as most felid species are predominantly nocturnal or crepuscular, exhibiting a substantial portion of their behaviour at night, quantifying how sand cats spend their time during their natural circadian rhythm, undisturbed by staff or visitors can provide an important insight into their natural behavioural repertoire.

Activity levels

In this study, the largest portion of time the was spent displaying alert behaviour (28.01%), locomotion (25.03%) and socializing activities (16.54%), whilst Resende *et al.*, (2014) studied the activity budget of 10 *Oncilla* cats (*Leopardus tigrinus*) using a similar study design for 24 hr per day during 3 consecutive days and found individuals spent the largest portion of the time (66%) resting, moving (20.66%) and vigilance (6.08%) were the second and third most common activities, respectively, followed by feeding (3.12%) however the higher percentage of inactivity in this study may be attributed to the diurnal observations included in the

activity budget of this species.

The high percentage of alert activity observed in the sand cat kittens may be attributed to enclosure design as the enclosure is half open (covered by mesh) where animals are often seen watching different activities occurring outside the enclosure, watching animals housed next to their enclosure and perceiving each other's behaviours. The surrounding setting often plays a significant role in the animals' nocturnal behaviour, as the animals were housed in close proximity to other carnivore species and may react or respond to visual or auditory stimuli from other species or conspecifics which may not be clear to the observer. While inactivity was higher, this could be attributed to the nocturnal nature of the animal as they often spend large periods of time resting and hiding inside nest boxes or on higher ground out of the camera view. It is possible that other active behaviours were not observed and recorded due to the limitation of the camera position, which could only capture 50-60% of the total enclosure area, therefore resulting in a higher percentage of inactive behaviour.

Figure 5 indicates that peak activity occurred between 19:00-20:00 hours and between 01:00-06:00 hours. This shows that the animal's circadian rhythm is not strictly nocturnal and indicates crepuscular activity. Resende *et al.*, (2014) found similar observations in *Oncilla* cats where activity levels were high from 05:00-06:00 hours and gradually decreased through the day only to peak again at 19:00 hours.

Leopardus tigrinus individuals spent the largest portion of the time (66%) resting. Moving (20.66%) and vigilance (6.08%) were the second and third most common activities, respectively, followed by feeding (3.12%).

Nocturnal Behaviours

Of the total 15 behaviours listed in this study, there are other specific behaviours that were classified together as one behaviour, such as walking and running for locomotion: hunting stance, stalking, and pouncing for hunting behaviour. Behaviours showing two or more individuals engaging in a group activity such as chasing, grooming, fighting, and playing are recorded as socializing behaviour. Scratching has been classified as separate behaviour rather than 'Interacting with enrichment and furnishing' behaviour. Vocalization was detected only twice during the entire study and was heard between the two animals during a fight. Another animal vocalization was recorded but not included in the analysis as it was not known if it really came from the

studied individuals or from their parent's enclosure which is a few meters away from the kittens' enclosure.

Limitations of the study

This research focuses primarily on the nocturnal activity of the animals; therefore, data collection is limited to between 19:00-06:00 hours. The animals may or may not have displayed other behaviours beyond the timeline of data collection. The infrared camera has an estimated 5-meter range to get good quality and clear video recordings and photos, which results in some restrictions during data collection where the camera may fail to record activity beyond the visual range of the camera set-up. Data sampling days were not recorded continuously due to the camera's battery life limitation. The camera trap had to be charged in between data collection, and the randomized study schedule was also the reflection of the researcher's working schedule, accounting for days off duty.

CONCLUSIONS AND RECOMMENDATIONS

This study helps us to understand more about the nocturnal behaviour of captive sand cats, and this may serve as a baseline study for future behavioural research for the species and other small nocturnal felids. The outcome of this study may benefit animal care professionals to enhance and improve their husbandry practices by providing more enrichments that can be left overnight when activity and engagement will likely be most high. Further studies using closed circuit television (CCTV) camera on a 24-hour recording are recommended to account for any diurnal activity leading up to sunset prior to 19:00 hours, to gather adequate information and to obtain more detailed results.

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