Activity and enclosure use of a sand cat in Parken Zoo, Eskilstuna

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Abstract

The escalating extinction of wildlife puts a high pressure on the standard of ex situ conservation. Some animals may spend several generations in captivity which may affect their natural behaviors and also a future reintroduction into the wild. Observations of animal behavior among captive animals are crucial for the understanding of ex situ conservation effects on behavior and in order to introduce and improve environmental enrichment. This study investigates activity and enclosure use of a sand cat (*Felis margarita*) at Parken zoo in Eskilstuna Sweden. Direct observations of behavior and movements were carried out and audience impact was also analyzed. The sand cat in the present study showed no behavioural response to the audience but it had some effect on his location in the enclosure. I also found that he was more active during late afternoon after feeding time and that he slept most during the forenoon. He used the whole enclosure to some extent but he spent most of his time in the cave, the front and the middle of the enclosure. Although he did not show any typical stereotypic behavior he had some odd habits that could probably be prevented through environmental enrichment.
Introduction

The earth is facing a continuous increasing extinction that goes far beyond the normal extinction rate. According to the International Union for the Conservation of Nature’s (IUCN), the list of endangered vertebrates has increased from 1 700 in 1988 to 5 188 in 2004. The total number of endangered species on the IUCN:s red list are 31 002 (IUCN, 2004?).

Today’s extinction differs from natural extinction in the sense that it is happening approximately a hundred to thousand times faster than normal and that it is mostly due to human activities (Botkin & Keller 2007). The main factor to the increased extinction is habitat destruction due to industrialization (Townsend et al. 2003) and this factor continues to increase. Other factors affecting animal extinction are overexploiting of natural resources and introduction of new species to new environments (Townsend et al. 2003).

Since many animals’ natural environments are exposed to some kind of destruction their only chance for survival might be ex situ conservation although in situ conservation always is preferable. Ex situ conservation encounters difficulties that might influence animal welfare. It is most often carried out in a zoo which means that animals are exposed to environments that are not natural for them and since conservation projects might go on for many years this can affect animal behavior. If essential behaviors such as antipredator behavior and hunting skills are affected in the captive environment it can reduce the animals chances to survive after reintroduction to its normal environment (Håkansson & Jensen 2004; Håkansson et al. 2006; Newberry 1995). It is therefore important that captive environments assure species specific needs.

Suboptimal environments and the lack of opportunities for the animals to perform species specific behaviors (Swaisgood & Shepherdson, 2005) can result in abnormal behaviors such as excessive grooming, self-plucking of hair and stereotypic behaviors (Carlstead et al.1993). Even stress can result in the same type of behavior although underlying stimuli are missing (Swaisgood & Shepherdson, 2005). The expression of abnormal stereotypic behaviours does not always imply that the present environment is suboptimal. It could also mean that a previous environment has been suboptimal and that this has affected the animal’s central nerve system (Swaisgood, 2006). Since stereotypic behavior is a way for the animal to cope with a suboptimal environment it could be so that an animal that performs this kind of behaviour in a certain environment actually feel better than an animal that does not perform stereotypic behaviours in the same environment (Swaisgood & Shepherdson, 2005).

A method that is practiced in order to decrease the risk of stereotypic behavior is environmental enrichment (Swaisgood, 2006). Environmental enrichment is by Newberry (1995) defined as “an improvement in the biological functioning of captive animals resulting from modification to their environment”. By the opportunity to perform natural behaviors animals feel that they have control over their environment and they feel better (Garner 2005).

Food enrichment is the most studied type of enrichment. A diet with an incorrect balance of nutrients can have effects on animal behavior. It has for example been seen that horses that do
not get the right balance of vegetable fibers often show abnormal oral stereotypic behavior (Young, 1997). The feeding of animals that are supposed to be reintroduced to their natural environment is far more complicated than knowing the right balance of nutrition. The diet has to be presented to the animal in a way that stimulates its natural feeding behavior. The numbers of feedings per day and whether the feeding occurs on a fixed or random basis over the day can have great impact on animal welfare (Young, 1997). Many obligate carnivores such as *Felidae* eat several small meals per day and studies have shown that domesticated felid that eats two to three big meals per day often get bladder stones (Young, 1997). Although there are no such studies made in small exotic felids it is not impossible that it may occur in these felids as well. Further studies have shown that animals that are allowed to choose between working for their food compared to getting it served on a plate prefer to work for it (Mellen & McPhee, 2001; Young, 1997). This indicates that animals have a biological instinct to forage and denying animal foraging opportunities might be a source of frustration and stress (Mellen & McPhee, 2001) that could lead to stereotypic behaviors.

Another type of enrichment is olfactory enrichment. The idea of this type of enrichment is that odors may have psychological effects and that this may be an important way to identify conspecifics and determine their reproductive status and maintains territories (Skibiel et al. 2007). It has been shown that olfactory enrichment can increase the amount of time in active behaviors but that it should not be made to often because it might lead to habituation (Wells & Egli, 2003)

Other types of enrichment could be the design and texture of the enclosure and also different sounds. A combination of several different kinds of environmental enrichment has been proved to be the most successful way to reduce stereotypic behavior. This supports the theories that stereotypic behavior is not a response to a single factor but that there are several underlying factors causing it (Swaisgood & Shepherdson, 2005).

To be able to introduce the right kind of enrichment for a particular animal it is important to study the current activities and enclosure use performed by that animal before any enrichment is introduced. The aim of this study was to investigate the activity and enclosure use of a single male sand cat (*Felis margarita*) in Parken zoo in Sweden. The findings from this study will help us to find suitable environmental enrichments for this sand cat. This study will later be followed up with a study investigating changes in the male sand cat’s behavior when a female companion is introduced to the enclosure.

The sand cat is one of many endangered species that are being breed in captivity. In the year 2000 the sand cat was classified as least concern in the IUCN redlist,(Nowell 2002) today it is classified as near threatened (IUCN 2008) There are approximately 50 000 individuals left in the world today and they are threatened by habitat destruction and local hunting (IUCN, 2008). This desert living animal has been poorly studied both in the wild and in captivity and therefore we know little about how we should carry out environmental enrichment in order to increase its natural behavior. In the wild the sand cats can be found in the stony and sandy desert in North Africa and Southwest Asia. It is well suited to the desert with their short, thick
coat and hairy pads that allows it to move easier across the hot sand. The sand cat is a solitary living species that is active mostly during the night and sleeps in bushes and caves that they dig in the sand during the hot hours of the day. It is believed to hunt mostly rodents such as gerbils but even reptiles, birds and arthropods are possible preys. It has also been found that sand cats can hide bigger preys in the sand and come back to feed on them several times. The sand cats’ big ears provide them with an excellent hearing that is thought to be helpful when they hunt animals that moves under the sand. The hearing is also thought to be helpful for communication between conspecifics especially during mating time when they emit short yelps (IUCN/SSC, 2008).

Materials and methods

Animal and facility
The study animal was a single captive born adult sand cat male in Parken Zoo in Eskilstuna Sweden. The sand cat was housed in a 70m$^2$ enclosure which contained rocks, water, trees and several hiding places including a cave (see fig. 1).

Three different caretakers took care of the health and feeding of the animal and cleaning of the enclosure. The study animal was fed twice a day on fixed feeding times, 8:00 in the morning and 15:00 in the afternoon with a total amount of 250g mice, chicken or rats that were scattered in one part of the enclosure. All meals consisted of full carcasses. The only interaction between animal and caretaker took place during cleaning although no physical interaction took place. Besides the structure of the enclosure and the feeding no form of environmental enrichment took place before or during the study.

![Diagram of zones in the Sand cat enclosure](image)

Figure 1: Division of zones in the Sand cat enclosure. Zone T consists of trees and bushes, zone V consists of water, zone E consists of stones, zone S is a cave, zone SS consists of logs and stubs, zone P is stone slabs, zone F is the front of the enclosure, zone M is the midie and zone B is the back of the enclosure.
Data collection
Data were collected between 30 June and 25 July, 2008. Behaviors were directly observed in one-hour sessions consisting of ten five-minute intervals. A timer that beeped every minute was used to keep track of the time. Between each interval there was a one-minute break during which no observations were made. The observed behaviors were divided into events (table 1) which were recorded continuously and states (table 1) that were recorded once a minute (at the beep).

<table>
<thead>
<tr>
<th>States</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping</td>
<td>Laying down with head on the ground an eyes closed</td>
</tr>
<tr>
<td>Laying passive</td>
<td>Laying down without being vigilant</td>
</tr>
<tr>
<td>Laying active</td>
<td>Laying down being vigilant</td>
</tr>
<tr>
<td>Sitting</td>
<td>Sitting down</td>
</tr>
<tr>
<td>Standing</td>
<td>Standing</td>
</tr>
<tr>
<td>Walking</td>
<td>Walking</td>
</tr>
<tr>
<td>Running</td>
<td>Trotting or galloping</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Events</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroking</td>
<td>Animal stroking olfactory glands to an object</td>
</tr>
<tr>
<td>Clawing</td>
<td>Animal scratching its claws to an object</td>
</tr>
<tr>
<td>Scent marking</td>
<td>Animal releases spray from posterior toward an object</td>
</tr>
<tr>
<td>Investigating</td>
<td>Investigates objects in the enclosure</td>
</tr>
<tr>
<td>Feeding/drinking</td>
<td>Eating , chewing or licking on edible substances or drinking</td>
</tr>
<tr>
<td>Urinating/defecating</td>
<td>Any projection of body fluids except from scent marking</td>
</tr>
<tr>
<td>Jumping</td>
<td>Jumping up or down from objects</td>
</tr>
<tr>
<td>Grooming</td>
<td>Animal licking or scratching itself</td>
</tr>
</tbody>
</table>

In order to get a picture of enclosure use the enclosure was divided into nine different zones according to structure and design (Fig 1). At the same time as state was recorded the zone in which the study animal was located was also noted. In that way a picture of the activity and enclosure use was created. In order to see if the study animal was affected by the audience this was also appreciated and noted as number of people 0, 1-5, 5-10 or above 10 each observation minute.

The amount of sessions were scattered equally over the opening hours (10:00 to 18:00) during a four week period. The total amount of observation hours was 92.

Data analyses
The analyses of collected data were made using Statistica version 6 (StatSoft Inc 2004). For the normally distributed data Pearson correlation Test and t-test were used and for the data that were found not to be normally distributed Spearman rank correlation and Mann-Whitney U test were used. States were given rate values that are a weighed average of the seven
variables (number of states, table 1). Audience was also given rate values using a weighed average of the four variables, 0, 1-5, 5-10 and above 10.

Results

Activity rate over the day

The activity rate increases over the day (rs = 0.24, N=92, p= 0.02) (fig. 2) and the sand cat is most active after three a clock in the afternoon. The rate of investigating behavior (N=92, R=0.32, p=0.002) (fig. 3), marking of the enclosure (N=92, R = 0.27, p=0.009) (fig. 4) and jumping (rs=0.26, N=92, p= 0.001) (fig. 5) also increases over the day and occurs most after three a clock.
The study animal were least active during the mornings (fig. 2) and he also spent more time in the cave during this period ($rs=-0.46$, $N=92$, $p=0.000004$) (fig. 6). During the afternoon when he were more active (fig. 2) he spent more time in the front ($rs=0.61$, $N=92$, $p=0.00000$) (fig. 7) and the middle ($rs=0.41$, $N=92$, $p=0.00005$) (fig. 8) part of the enclosure.
Audience impact

There were a decline in number of audience towards the afternoon \( (rs=-0.2, N=92, p=0.049) \) (fig. 9). There were no correlations between audience and state or event but correlations between audience and zone were found. The sand cat spent more time by the trees and bushes (zon T, fig 1) when the number of audience were high \( (rs=0.28, N=92, p=0.0077) \) (fig. 10). He also spent more time in the front of the enclosure (zon F, fig. 1) when the number of audience were low \( (rs=-0.24, N=92, p=0.022) \) (fig.11).
Discussion

The sand cat in the present study was more active during late afternoon and spent most of the forenoon in an inactive state. Evaluations of activity rate among small felids are lacking but where data exists it has been shown that free ranging wildcats spends about 43 percent of the daylight hours in an active state (Mellen 1998). The activity rate is however to a certain extent species dependent so any direct comparisons between the amount of active state performed by this sand cat and the result shown above cannot be made. The value can though act as a guideline when it comes to which extent captive felids should be activated in zoos.

Calculations of the amount of time spent in different states during the whole study period (fig 12) shows that if sitting, standing, walking and running are considered to be active states this sand cat spent 46 percent of the study time being active. Compared with a wild free ranging cat’s activity rate this fits fairly well. If laying active are included as an active state the amount of time spent active during the study period increases to 49.8 percent, this is still not that much more than for free ranging wild cats.

The distribution of states over one single day of studies during all opening hours (fig 13) shows that if we still consider sitting, standing, walking and running to be active behaviour he spent 44 percent of his time active during that day. This still fits well with the data on free ranging wild cats. If laying active are included in active states the amount of time spent in an active state increases to 74.5 percent which is far more than the values from free ranging wild cat. I want to point out that this value are just from one single day and do not represent the animals actual activity rate.

![Distribution of states over the study period](image)
Overall this sand cat can be said to have about the same rate of active behavior as a free ranging wild cat. The quality of the active time is however more important than the amount (Wells & Egli, 2003, Mellen et.al., 1998) and I think that it in this case is more important to look at the quality.

The sand cat in this study were most active around 15:00 and 17:00 which may be due to a response to the feeding which occurred between 15:00 and 16:00. As he also showed most of the investigating behavior during this time it could be that the feeding may trigger a foraging behavior which is expressed by him being more active and more investigating. Most of these active times were though spend in what seemed to be aimless movement around the enclosure. He did return to the same paths in the enclosure which is probably just a routine rout as is also seen in wild cats (Mellen et. al., 1998) and not stereotypic pacing behavior. The aimless movement is undesirable and could perhaps be prevented and replaced with more beneficial behaviors by providing a more time spending feeding way. In the wild small felids hunt on the basis of two strategies. They either patrol there home range until prey is encountered or waits to ambush the prey in concealment and because most food items are pretty small they often repeat this food searching behaviour several times each day (Mellen et. al., 1998). The feeding in the zoo often finished within a few minutes and the sand cat might have felt frustrated because he did not get to express his foraging behavior and therefore were not satisfied after feeding. This frustration may be prevented by presenting different kind of feeding opportunities. In the wild sand cats often eat insects which could be offered in captivity as well as an addition to his current diet. Since living insects can be presented to the animal this may also stimulate his hunting behavior. An earlier study has shown that sand cats among whit other small felids shows an interest in hunting living crickets and feedings whit living crickets in a container that allows the crickets to escape whit different time spans have had good effects on small felids (Mellen, 1998). In the wild sand cats also often hunt gerbils that moves under the sand and they are very depended on their hearing when they hunt so maybe some type of feeding strategy that allows the sand cat to use his hearing could be introduced.

Since we still want the animal to be active without being stressed it is important to introduce more time spending enrichments that this sand cat can fill up his time whit so the rate of aimless patrolling and the risk for developing stereotypic behavior decreases. Introducing the right type of enrichment in an appropriate way is though harder than it might seem to be.
Introducing the same type of enrichment only a few times might lead to unwanted habituation (Tarou & Bashaw, 2006, Wells & Egli, 2003). Earlier studies have shown that an intrinsically reinforcing enrichment (enrichments stimulating exploration, playing or hunting behaviour) that have an external outcome such as finding food can reduce the risk of habituation (Tarou & Bashaw, 2006). If the earlier suggested food enrichment with the crickets could be complemented with several boxes hidden over the enclosure and perhaps even buried in the sand this could stimulate hunting behaviour as well as exploratory behaviour. And since crickets and other arthropods often emit noises this could also be an opportunity for the sand cat to use his hearing when searching for the food.

The sand cat also seems to know the feeding time fairly well which could make him to build up a tension as he sits and waits for the food to come and after the feeding is finished, which always took less than five minutes, he still had a lot of tension built up that he had to get out and this could result in this aimless patrolling. Another worrying thing is that as he sat and waited for the food and heard the caretakers coming in to the adjacent room he performed “a ritual run” first twice and then he paced in front of the door from where the caretaker handed in the food and repeated the run until the food was served. Since the behavior is not repetitive in the sense of a stereotypic behavior it cannot be called that but it is an abnormal unwanted routine that need further attention. This behaviour could maybe be prevented by introducing unfixed feeding times. An observation outside the frame of this study was noted at one day when the feeding times unintentionally were changed. The feeding occurred at a time when the sand cat was not expecting it and he did not perform the “ritual run”. The effects of a fixed versus an unfixed feeding schedule are something that needs to be followed up in a later study. Introducing more small meals per day with a greater dietary diversity containing of full carcasses such as mice or chickens could result in less time spent in aimless moving (Mellen et. al., 1998).

So far I have discussed the patrolling behaviour observed only from a food searching perspective but felids may patrol their environment for other reasons. Patrolling there home range looking for intruders or mates or perhaps looking for hiding places may be other reasons (Mellen et. al., 1998). For the first two of these examples olfactory stimuli are important factors in animal communication by identifying conspecifics, determine their reproductive status or maintain territories (Skibiel et al. 2007). Except changed feedings with more variations in presenting of the food and food choices olfactory enrichments with different kinds of spices and scents from different animals could be added to the food enrichment. Olfactory enrichment should though not be introduced at the cost of other types of enrichment but as a complement to them. Different scents may have different effects on different kinds of cats. Catnip (Nepeta cataria) which is believed to act as a aphrodisiac for domesticated cats (Felis catus) also have a euphoria effect on lions whiles tiger and bobcats do not show any signs of that kind of response (Wells & Egli, 2003). It is possible that the same diversity in response could be seen in other types of species and odors. A future study on the response of olfactory enrichments for sand cats would be interesting. Either by introducing new objects that has a scent added to it or by adding liquefied odors directly to objects already in the enclosure. When using olfactory enrichments it is however important not to introduce the same scent to often but instead introduce them in a regular rotating way in order to minimize the risk of habituation (Wells &Egli, 2003).

The number of animals in the enclosure also seems to have an impact on the individual activity rate. In the wild the sand cat are a solitary species but in captivity they are often held
in pairs in conservation projects. An earlier study (Mellen et. al., 1998) suggests that sand cats and other small felids should never be in groups bigger than two since trios seems to be much less active than couples. Felids held in trios are also less likely to reproduce than felids held in pairs. This response is thought to be due to social stress.

Conclusions
The sand cat in this study does not show any typical stereotypic behaviour and he has, what seems to be, a normal activity rate. The active time is though filled whit aimless movement and he do return to the same patterns quite often why more types of environmental enrichments are requested. No single form of enrichment is effective indefinitely, much because felids easily get habituated. Therefore a variation in food, olfactory and novel objects displayed in a rotating way should be the most effective way to enrich this animal’s environment.

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