THE EFFECT OF VISITATION ON THE BEHAVIOR OF CAPTIVE INDIVIDUALS OF *Panthera onca* (LINNAEUS, 1758)

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ABSTRACT. The jaguar (*Panthera onca*) is the biggest living feline in the Americas and, like many large predators, is threatened by habitat loss and persecution. One response to these threats is ex situ conservation through zoos. However, captive environments do not have the same diversity as natural environments with potentially negative effects on the general health of individuals and their behavior. Here, we assess the behavior of four captive jaguars in Curitiba Zoo, Southern Brazil, on days with different visitation rates with the aim of testing if there is a relation between human visitation and stereotypic behaviors. All four jaguars predominantly engaged in resting behavior but showed an increase of stereotypy on days with more visitations. Moreover, it was also possible to show that each animal responds differently to negative stimuli from visitation and that its behavior presents marked differences because they are in captivity and on display.

RESUMO. O efeito da visitação no comportamento de indivíduos de *Panthera onca* (Linnaeus,1758) cativos. A onça-pintada (*Panthera onca*) é o maior felino vivente nas Américas e como outros grandes predadores, sofre com a perda de habitat e com a caça ilegal. Uma resposta a essas ameaças é a conservação ex situ por meio de zoológicos. Entretanto, os ambientes de cativeiro não possuem a mesma diversidade que o ambiente natural, podendo causar efeitos negativos na saúde geral dos indivíduos e em seu comportamento. Assim, este trabalho teve como intuito registrar o comportamento de quatro onças-pintadas cativas no Zoológico Municipal de Curitiba, no sul do Brasil, em dias com diferentes fluxos de visitação, para analisar se existe relação entre a visitação e a presença de estereotipias. Todos os indivíduos apresentaram a categoria de repouso como a mais significativa em todos os dias e aumento da estereotipia em dias com maior visitação. Foi possível evidenciar ainda que cada animal responde de uma forma diferente aos estímulos negativos provenientes da visitação e que seu comportamento apresenta diferenças marcantes por estarem em cativeiro e em exposição.

Key words: captivity, jaguar, stereotypy, visitors, zoos.

Palavras-chaves: cativeiro, estereotipia, onça-pintada, zoológicos

INTRODUCTION

The jaguar *Panthera onca* Linnaeus, 1758 is the biggest living feline in America (Leite 2000; Silva 2011; Vidal et al. 2016). Due to their dependence on larger prey, they are particularly sensitive to the extensive habitat loss and fragmentation that is associated with industrial, farming, and infrastructural activities (Silveira 2004). Like many other large predators, jaguars are also targets of persecution, mainly as a consequence of their perceived threat...
to livestock (Mantovani & Pereira 1998; Silveira 2004; Zeilhofer et al. 2014). This threat increases as natural resources dwindle and the jaguars replace their natural prey with domestic animals (Zeilhofer et al. 2014).

The most adequate way to conserve viable populations of the jaguar is through the preservation of its natural habitat. However, given the large area requirements and limited resources for new protected areas, this strategy is ineffective through much of the jaguar’s range (Silveira 2004). A complementary strategy is ex situ conservation by means of sanctuaries or zoos (Sepúlveda 2008). In addition to education and entertainment, most zoos also promote the conservation of endangered species and are actively involved in scientific research and captive breeding programs (Garcia 2009; Pimentel et al. 2009). These programs pursue to increase the genetic variability of the species, dismissing individuals that result from a high level of inbreeding due to small population size, and genetic adaptations to captivity that can be dangerous to wild populations are not the subjects to these programs (Frankham 2008; Robert 2009). The ultimate aim of many captive breeding programs is maintaining populations that can eventually be reintroduced in the natural environment when conditions are favorable (Javorouski & Biscia 2007; Garcia 2009) improving the genetic load of wild populations (Robert 2009).

Clearly, the captive environment is very different from the wild (Davey 2007; Vidal et al. 2016), especially in terms of lack of structural/ecological complexity, greater predictability, and ease in obtaining food with little energetic costs (Vasconcellos 2009; Silva 2011). Under such conditions, large predators may suffer from neurological and developmental problems. In extreme cases, captivity may result in anatomical and physiological alterations, associated with stress and abnormal behavior (Pereira et al. 2009; Gonçalves et al. 2010; Silva 2011). One of the most characteristic abnormal behaviors shown by captive animals is called stereotypy: repetitive behaviors that lack an obvious function or clear objective (Castro 2009). The most common stereotypy seen in captive felines is pacing, the behavioral act in which the animal repeatedly walks from one side of the enclosure to the other (Mason et al. 2007; Silva 2011; Vidal et al. 2016). Nevertheless, captivity is not necessarily synonymous with stress and a low welfare condition. The “use” of an animal for conservation and environmental education purposes should be tied to the obligation to maintain its quality of life, encapsulated by the five freedoms created by the Brambell committee (Brambell 1965; Fischer & Oliveira 2012; Ohl & Van Der Staay 2012).

These are defined as: being free from thirst, hunger and malnutrition; free from discomfort, possessing shelter and a comfortable resting area; free from pain, lesion or any type of illness; free to express its natural behavior and free from any type of fear or stress (Gonyou 1994; Hötzel & Machado Filho 2004; Fischer & Oliveira 2012).

One of the obvious challenges for zoo management is how to manage the influence of visitation on captive animals. Most wild animals have very little interaction with humans (Montanha et al. 2009) and simple, direct contact with visitors could have negative consequences (Wells 2005; Gonçalves et al. 2010; Silva 2011). Moreover, the constant noise associated with visitors (Carvalho 2008), could also cause multiple physical and psychological alterations (Almeida et al. 2008).

This study assessed the influence of different visitation rates on the frequency of stereotypic movements of captive jaguars in the Municipal Zoo of Curitiba, Southern Brazil. We propose measures to minimize stress and promote the welfare of captive jaguars.

**MATERIALS AND METHODS**

**Study area**

The Municipal Zoo of Curitiba is localized inside the Municipal Park of Iguaçu in the city of Curitiba in an area of 589 000 m². It is open to the public from Tuesday to Sunday, including holidays. The zoo was created in 1976 with the aim of preserving the rearmost valley of the Iguaçu River, sheltering large mammals that were confined to other zoos in the same city (“Passeio Público”) and also with the intention of captive breeding native animals, and as a safe harbor for migrating birds (Sans 2008). The zoo currently hosts about 1 800 animals, including mammals, birds, and reptiles (Almeida et al. 2008).

**Study animals**

We analyzed four captive jaguars: two females (Angélica and Maya) and two males (Apollo and Ares). Angélica and Maya came from Manaus (Amazonas State, Brazil) in 2006, without a previous record, but it is known that both are over 20 years old. Maya and Ares are cubs from the couple born in the zoo in 2007 and 2010 respectively. Each animal has its own enclosure with an area of about 86 m², containing trunks, earth, sand, and some grass. Each enclosure has a covered area in the back, occupying approximately a third of the enclosure, and an open area that has a net above it. **Fig. 1** shows the distribution of the enclosures and their divisions.

**Data Collection**

Before data collection started, the jaguars went through a process of habituation to get used to the presence of...
The animals were analyzed individually according to the duration of the behavioral categories between the days (Silverio 2015). Behavioral category frequencies were analyzed by the chi-square test in the software Past 3.x, comparing the different categories to each sample grouping (Mondays, Wednesdays, Saturdays, and Sundays). Values of P lower than 0.05 were considered significant.

This work was approved by the Ethics Commission in Animal Use of PUCPR (01101/2016).

**RESULTS**

A behavioral repertoire of the individual jaguars was successfully collected during the habituation period (32 hours per animal), summing 37 behavioral acts in nine behavioral categories (Table 1).

**Behavioral categories in each sample grouping**

Resting was the most common behavior for all four individuals, independent of grouping (Table 2). In Angélica’s case, locomotion was the next most frequent behavior, while Maya had high frequencies of both stereotypy and the locomotion. Ares also had a high frequency of stereotypic behavior and engaged in the highest amount of stereotyping each day. The other male, Apollo, had the second-highest level of stereotypy. It was observed that all four individuals had a strong tendency to engage in stereotypic behavior near the border of the enclosure closest to the visitors (Fig. 2).

**Behavioral categories by days**

Angélica showed a significantly higher frequency of territorial marking behavior on Mondays ($\chi^2 = 92.33; p < 0.0001$) and less social interaction ($\chi^2 = 35.89; p < 0.001$) (Fig. 2). On Wednesdays, she presented less social interaction ($\chi^2 = 33.96; p < 0.001$) and more stereotypy on Saturdays ($\chi^2 = 10.58; p = 0.05$) (Fig. 2).

Maya showed more territorial marking behavior on Wednesdays ($\chi^2 = 65.60; p < 0.001$) (Fig. 2)
Table 1

Behavioral repertoire of the jaguars at the Municipal Zoo of Curitiba (adapted from Silverio (2015) and Stanton et al. (2015)).

| Behavioral category   | Behavioral act | Description |
|-----------------------|----------------|-------------|
| **Maintenance**       | Stretching     | Stretches the body or part of it, stretching the muscles |
|                       | Groom          | Performing maintenance of the fur through the removal of dirt, water or body fluids, with the direct help of the tongue. |
|                       | Scratching     | Scratches its body using the claws, teeth or structures within the enclosure. |
|                       | Insect control | Removal of insects through dorsal tremors and/or whipping movements with the tail towards the back and/or ear movement. In some cases, the animal tries to remove the insects by biting them. |
|                       | Vomiting       | Ejects stomach contents - digested or not - out of its mouth. |
| **Territorial/ Marking** | Clawning       | Scrapping claws on the substrate. |
|                       | Defecate       | Smelling the ambient in search of a specific local and expelling feces. |
|                       | Urinate        | Smelling the ambient in search of a specific local and expelling urine. |
|                       | Face Rub       | Rubbing the side of the face and/or chin on an object. |
| **Exploratory**       | Play           | Entertaining itself in activities that are usually related to the environmental enrichment material. |
|                       | Alert          | Interrupting an activity and concentrating its attention on something in the environment. Directing the eyes and auricles towards a visual and/or sonorous stimulus. |
|                       | Sniff          | Inhaling environmental odors. The animal can direct itself to the source of the odor or just sniff the air. Note, in some moments, the animal moves the nose and chest; in some cases, the animal can raise its chin and inspire the air vigorously. |
|                       | Flehmen        | The animal stays with its mouth open, raising the upper lip and exposing the tip of its tongue while inspiring. |
|                       | Lick           | Licking a substrate not related to feeding or cleaning. |
|                       | Foot on the grid | Supporting its body on its hind legs while its front legs are supported on the grid. |
|                       | Inside the house | When they go inside the covered house. |
|                       | Dig            | Turning the dirt or digging a hole with its paws. |
| **Social interaction** | Social face rub | Rubbing the side of its face on another individual, even if separated by the grid. |
|                       | Charge         | Charging against another. |
|                       | Social play    | Developing activities with another individual, similar or not. |
|                       | Vocalize       | Produce sounds or calls with the throat and mouth. |
|                       | Crouch         | Maintaining the eyes fixed on something, body close to the ground and silent steps. |
| **Stereotypes**       | Pacing         | Walking from one side to the other repeatedly following a pattern. |
| **Rest**              | Sleeping       | Staying horizontally extended on the substrate, with the thoracic and pelvic members relaxed and/or flexed with the eyes closed. |
|                       | Lying          | Staying horizontally extended on the substrate, with the thoracic and pelvic members relaxed and/or flexed, but, maintaining the eyes open without being vigilant. |
|                       | Sitting        | The non-vigilant animal in an upright position, with the hind legs flexed and resting on the ground, while front legs are extended and straight. |
|                       | Accommodate    | Changing the stance without any displacement. |
| **Foraging**          | Drink          | Ingesting water by lapping up with the tongue. |
|                       | Eat            | Consuming organic substances. |
| **Locomotion**        | Locked         | Its food is placed inside the covered house and as soon as it is inside, they are locked. |
|                       | Walking        | Moving around at a slow gait. |
|                       | Running        | Moving around at a rapid gait. |
|                       | Jumping        | Animal leaps from one point to another. |
| **Reproduction**      | Masturbation   | The female rides a log and starts a series of come and go movements with its hip; can end the behavior with vocalization and running. |
|                       | Roll           | Turning from one side to the other, in dorsal decubitation, having as base the longitudinal axis of the body. |
|                       | Lordosis       | The female directs her posterior part to the male with the tail up, showing the vulva. |
|                       | Roll + dig     | Before completing the rolling behavior, still in dorsal decubitation, the jaguar moves its paws as if digging the air. |
and more stereotypic behavior on Saturdays. On Mondays, stereotypic behavior was significantly lower ($\chi^2=14.13; p < 0.01$) (Fig. 2).

Ares had significantly higher levels of social interaction on Wednesdays ($\chi^2=14.13; p < 0.01$) (Fig. 2) and higher maintenance behavior on Saturdays ($\chi^2=146.93; p < 0.001$). Reproduction behavior was also higher on Saturdays ($\chi^2=105.55; p < 0.01$); although it is worth mentioning that this behavioral category had a duration of only 16 seconds on Saturday (24 seconds in total over all the study days). Exploratory behavior was the highest on Sundays ($\chi^2=38.81; p < 0.001$) and the territorial marking significantly lower on this same day ($\chi^2=19.30; p < 0.01$) (Fig. 2).

Apollo engaged in more exploratory behavior on Mondays ($\chi^2=9.65; p < 0.05$) and less maintenance behavior on Saturdays ($\chi^2=17.56; p < 0.01$) (Fig. 2). Social interaction was significantly higher on Saturdays and lower on Wednesdays ($\chi^2=85.25; p < 0.001$); he also engaged in less territorial marking behavior on Sundays ($\chi^2=13.04; p < 0.001$). Reproduction behavior significantly differed in all the sample groupings ($\chi^2=111.37; p < 0.001$). Finally, foraging behavior was higher on Sundays ($\chi^2=15.78; p < 0.05$) (Fig. 2); although as commented previously, the animals did not receive food on this day, being the value significantly related to the behavioral act of "drinking water".

**Visitation and noise**

The number of visitors on the days with observation varied significantly between Wednesdays, Saturdays, and Sundays (Table 3), with the highest quantity on Sundays ($F=27.54; p < 0.001$). In terms of decibels, Angélica’s enclosure had similar levels of noise on Wednesdays, Saturdays, and Sundays, with Mondays similar to Saturdays and quieter than the rest ($F=6.46; p < 0.001$). A similar pattern was observed at Maya’s enclosure, although in this case, Sundays were clearly louder ($F=7.98; p < 0.001$). At Ares’ enclosure, there was a similarity between Mondays and Saturdays (quieter), Wednesdays, and Sundays (louder) and a significant difference between these two groups ($F=18.21; p < 0.001$). At Apollo’s enclosure, the sound on Mondays was significantly lower than the other groupings ($F=8.47; p < 0.001$).

It is also worth mentioning that on Wednesdays the visitors were usually related to school groups, and on weekends most visitors were families or informal groups. Many visitors on the weekends screamed, trying to wake up the animals. Others came with very loud music and even utilized the cellphone to emit gunshots sounds near the enclosures. Other visitors ate near the enclosures and on one Sunday, a visitor threw water on Apollo to see if it would wake up.
Table 2
Relative frequency of the behavioral categories presented by jaguars in the different observation days. The asterisk accompanies the significant value (P<0.05) between the categories in each day.

| Behavioral categories | Mon | Wed | Sat | Sun |
|-----------------------|-----|-----|-----|-----|
| "Angelica"            |     |     |     |     |
| Maintenance           | 0.54| 0.13| 1.20| 0.90|
| Territorial marking   | 0.65| 0.21| 0.09| 0.04|
| Exploratory           | 8.69| 8.04| 6.64| 4.94|
| Social interaction    | 0.00| 0.10| 0.12| 0.09|
| Stereotypy            | 5.47| 4.40| 8.80| 4.14|
| Rest                  | 50.11*| 45.36*| 42.52*| 60.35*|
| Foraging              | 11.15| 9.21| 6.41| 1.62|
| Locomotion            | 20.23| 28.21| 30.48| 23.84|
| Reproduction          | 3.16| 4.34| 3.74| 4.98|

| "Maya"                |     |     |     |     |
| Maintenance           | 1.49| 1.68| 1.68| 1.21|
| Territorial marking   | 0.10| 0.29| 0.04| 0.05|
| Exploratory           | 5.79| 5.60| 6.60| 3.04|
| Social interaction    | 0.04| 0.00| 0.04| 0.00|
| Stereotypy            | 7.56| 11.62| 21.62| 13.29|
| Rest                  | 64.04*| 55.87*| 43.66*| 69.98*|
| Foraging              | 9.27| 8.63| 9.29| 1.30|
| Locomotion            | 10.39| 14.78| 16.20| 10.50|
| Reproduction          | 1.32| 1.53| 0.86| 0.63|

| "Ares"                |     |     |     |     |
| Maintenance           | 0.04| 0.18| 0.66| 0.00|
| Territorial marking   | 0.21| 0.40| 0.42| 0.11|
| Exploratory           | 9.41| 7.06| 5.47| 5.65|
| Social interaction    | 0.02| 0.02| 0.00| 0.00|
| Stereotypy            | 24.08| 25.31| 36.11| 19.88|
| Rest                  | 50.20*| 51.18*| 39.78*| 63.97*|
| Foraging              | 5.90| 6.19| 7.67| 3.09|
| Locomotion            | 10.13| 9.66| 9.86| 7.29|
| Reproduction          | 0.01| 0.00| 0.03| 0.00|

| "Apollo"              |     |     |     |     |
| Maintenance           | 0.31| 0.49| 0.13| 0.50|
| Territorial marking   | 0.79| 0.63| 0.72| 0.24|
| Exploratory           | 2.82| 1.51| 1.90| 1.29|
| Social interaction    | 0.08| 0.00| 0.18| 0.04|
| Stereotypy            | 13.02| 19.92| 20.67| 9.72|
| Rest                  | 63.81*| 61.81*| 55.39*| 65.92*|
| Foraging              | 8.20| 4.15| 9.85| 14.25|
| Locomotion            | 10.95| 11.48| 11.47| 8.03|
| Reproduction          | 0.02| 0.00| 0.00| 0.01|

DISCUSSION

Our study demonstrated that visitation has an influence on the behavior of captive jaguars, altering the frequency of several behaviors and increasing the frequency of stereotypy. Furthermore, we demonstrated very high levels of individual variation between individuals in how they respond to stressful stimuli.

Jaguars do not have a single activity period. According to studies of Harmsen et al. (2011) and Monroy-Vilchis et al. (2009) this period is highly related to the period of its prey, in these studies it was shown that a jaguar can be both nocturnal, crepuscular or even diurnal. However, although the individuals studied for this research were observed in the morning – the same period that they are fed – rest behavior was always the most frequent behavioral category. High levels of inactivity may indicate a problem with the animal’s well-being (Mitchell & Hosey 2005; McPhee & Carlstead 2010).

A similar study with pumas at Curitiba zoo showed that the presence of visitors interfered with the behavior of the male of the species, with the animal resting for long periods (Costa et al. 2014).

It is important to note that data related to stress evaluation must be analyzed individually, because every animal will react differently, and this is related to its age, gender, personality or reproductive condition (McPhee & Carlstead 2010). For this reason, we analyzed the animals individually at every step, and will now discuss the differences found in detail.

Our analyses indicated that Ares had high levels of stereotypy in comparison to, for example, Angélica who engaged in the “normal” behavior of locomotion. The lack of stereotypic behavior does not, however, indicate a lack of stress as even normal locomotion behavior could be a sign of restlessness. This is corroborated by Guimarães’s (2012) study of capuchin monkeys which showed that an excess of displacement can also be tied to stress.

Territorial marking and maintenance behavior appear to be lower on days of higher visitation, suggesting that more “natural” behaviors are depressed in response to the stress of visitation. Jaguars commonly use these marks - scratches, urine or feces - in their natural habitat to inform about their presence, identity, and health, for the species or others (Palomares et al. 2018). Moreover, inadequate level of territorial markings is an indicator of poor well-being in various species (Mitchell & Hosey 2005). The restricted space in captivity likely makes the jaguar spend less time patrolling and marking its territory, even though these behaviors are very common under natural conditions (Szokalski et al. 2012). Recent work on captive lions (Panthera leo (Linnaeus 1758)) also found that inactivity and pacing were the two main behavioral categories (Novo & Santos 2014). However, after the application of environmental enrichment techniques (EE), the behavioral repertoire increased to include natural behaviors such as territorial marking (Novo & Santos 2014). Silverio’s (2015) study of the same jaguar individuals used in the present study also demonstrated that the introduction of EE promoted the expression of natural behaviors and significantly lowered stereotypic ones.
Noise levels varied between days and enclosures. In general, these levels were higher on Sundays (peak visitation) and similar on Saturdays and Wednesdays. If compare these measurements with the background-noise level in natural environments such as forests, the later can be predominantly lower (Ellinger & Hödl 2003). In a neotropical rainforest, the sound varies from 20 to 30 dB for most of the day, picking in short periods in the sunrise and sunset (50-60 dB) due to dawn chorus of birds and dusk chorus of insects, respectively (Ellinger & Hödl 2003). So, the sound intensity measured for prolonged periods in this study is thought to be associated with stress in captive mammals (Morgan & Tromborg 2007). Indeed, a study on pumas demonstrated that visitor noise significantly influenced individual behavior, with inactivity being positively associated with higher noise levels (Maia 2009).

We observed that both females, Angélica and Maya, presented significantly higher stereotypic behavior on Saturdays, though showed very little of this behavior on Sundays (even though this is the peak day for visitation). Likewise, Apollo engaged in less stereotypic behavior on Sundays. These findings are probably related to the lack of food on this day (the jaguars are not fed on Sundays), with individuals responding by saving energy and engaging in more resting behavior. Maya also engaged in less stereotypic behavior on Mondays when the zoo is closed to visitors, once again suggesting a causal link with visitation levels. These findings support the recent work of Vidal et al. (2016) on jaguars, which showed an increase in stereotypic behaviors was related to visitors near the enclosure. Nevertheless, all the animals still engaged in low levels of stereotypy on Mondays, possibly related to the longer-term effects of Sunday visitation or in response to other aspects of the captive environment (Mitchell & Hosey 2005). Moreover, almost all the stereotypic behaviors took place near the viewing area of the enclosure (near the visitors), supporting the results of a study of leopards (Panthera pardus) in an Indian zoo (Mallapur et al. 2005).

High numbers of visitors have been shown to increase cortisol levels in jaguars, indicating that visitation is stressful for the animals (Montanha et al. 2009; Silva 2011). Similar results have been seen for other physiological indicators of stress, such as fecal metabolites of glucocorticoids (Silverio 2015). Glucocorticoids (cortisol, cortisone and corticosterone), also known as the stress hormones (Moyes & Schulte 2010), are generated through a cascade of biochemical events related to emotional responses to negative environmental stimuli (Montanha et al. 2009).

As previously mentioned, many zoos seek to fulfill the dual function of education/environmental recreation aimed at visitors along with conservation and scientific research (Garcia 2009; Pimentel et al. 2009). The environmental education conducted at zoos is highly connected to the behavior of the captive animals, because the visitors tend to have a higher interest in conservation when they are exposed to healthy, active animals (McPhee & Carlstead 2010). Increasing the well-being of animals is therefore priority of zoo management. Possible strategies to this end include: i) the construction of appropriate sized enclosures with structures consistent to a species’ ecology (Clarke et al. 1982); ii) the implementation of glass windows that can muffle ambient noise and reduce the ability of the exhibits to see their human visitors, if they do not increase the temperature in the enclosures; iii) having places within the enclosure where the animal can hide itself from public view when it wishes to, and; iv) applying EE techniques that promote natural behaviors and reduce inappropriate behaviors.

| Sample grouping | Visitors | Angélica | Maya | Ares | Apollo |
|-----------------|----------|----------|------|------|--------|
| Mondays         | No visitation | 56.88 ± 2.07a | 56.94 ± 1.87a | 57.0 ± 2.17a | 56.73 ± 2.17a |
| Wednesdays      | 230 ± 188a | 58.85 ± 4.63b | 58.79 ± 2.70b | 59.37 ± 3.43b | 59.53 ± 4.66b |
| Saturdays       | 871 ± 544b | 58.48 ± 3.9ab | 58.04 ± 3.87ab | 55.86 ± 3.49a | 58.99 ± 3.63b |
| Sundays         | 1815 ± 807c | 59.89 ± 4.51b | 59.64 ± 4.17c | 60.04 ± 4.20b | 59.92 ± 4.26b |

Table 3
Mean values and standard deviation of the number of visitors at the Municipal Zoo of Curitiba and of sound intensity (dB) in each one of the four enclosures during the moments of observation of the different sample groupings. The letters represent the similar and different values between the groupings at each enclosure.
and to be shown how they can reduce the impact of their visit on the exhibited animals. For example, in a small zoo such as Curitiba, visitors could be divided into smaller groups on the weekends and accompanied by employees of the environmental education area during their visit - similar to what already occurs for schools and scheduled groups.

CONCLUSIONS

Our study confirms the results of previous research that visitation harms the behavior of captive jaguars, causing an increase in stereotypic behavior and an excess of inactivity. Possible solution to this problem includes restrictions on visitation and the improvement of the enclosure environment to promote natural behavior. Such improvements could include the insertion of new stimuli specific to each animal, being aware of their differences, as well as modifications to enclosures, regulation of visitor numbers and environmental education to change visitor behavior in front of the exhibits.

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LITERATURE CITED

Almeida, A. M. R., T. C. C. Margarido, & E. L. De Araújo Monteiro Filho. 2008. Influência do enriquecimento ambiental no comportamento de primatas do gênero Atelis em câtiveiro. Arquivos de Ciências Veterinárias e Zoológica da UNIPAR, 11(2), 97-102.

Altman, J. 1974. Observational Study of Behavior: Sampling Methods. Behaviour, 49:227-267.

Brabmell, F. W. 1965. Report of the Technical Committee to Enquire into the Welfare of Animal Kept under Intensive Livestock Husbandry Systems. Cmd 2836. London: HM Stationery Office.

Carvalho, C. O. 2008. Maus Tratos Contra Animais no Parque Zoológico Getúlio Vargas (Salvador-Bahia): Crítica para a Construção do “Zoológico do Futuro”. I Congresso Mundial de Bioética e Direito Animal, UFBA, Salvador.

Castro, L. S. 2009. Influência do Enriquecimento Ambiental no Comportamento e nível de Cortisol em Felídeos Silvestres (Masters dissertation). Universidade de Brasília, Brasília.

Clarke, A. S., C. J. Juno, & T. L. Maple. 1982. Behavioral effects of a change in the physical environment: a pilot study of captive chimpanzees. Zoo Biology, 1:371-380.

Costa, J. K., R. A. Silverio, & M. L. Fischer. 2014. Influência da visitação humana no comportamento de onças-pardas (Puma concolor Linnaeus, 1771) do Zoológico Municipal de Curitiba, Estado do Paraná (Undergraduate dissertation). Pontifícia Universidade Católica do Paraná, Curitiba.

Davey, G. 2007. Visitor`s effect on the Welfare of Animals in the Zoo: a review. Journal of Applied Animal Welfare Science, 10:169-183.

Ellenger, N., & W. Hödl. 2003. Habitat acoustics of a neotropical lowland rainforest. – Bioacoustics, 13: 297-321.

Fischer, M. L., & G. M. D. A. Oliveira. 2012. Ética no uso de animais: A experiência do Comitê de Ética no Uso de Animais da Pontifícia Universidade Católica do Paraná. Estudos de Biologia, 34:247-260.

Frankham, R. 2008. Genetic adaptation to captivity in species conservation programs. Molecular Ecology 17, 325-333.

Garcia, R. V. 2009. Visita monitorada no Zoológico de Sorocaba: um palco de negociação de saberes. Enseñanza de las Ciencias - VIII Congreso Internacional sobre Investigación en Didáctica de las Ciencias, 1610-1615.

Gonçalves, M. A. B., S. L. Da Silva, M. C. H. Tavares, N. V. Grosman, C. F. Cipreste, & P. H. G. Di Castro. 2010. Comportamento e bem-estar animal: o Enriquecimento Ambiental. In A. Andrade, M. C. R. Andrade, A. M. Marinho, & Ferreira-Filho, J. Biologia, Manejo e Medicina de Primatas não-humanos na Pesquisa Biomédica. Rio de Janeiro: Ed. Fiocruz.

Gonçalves, M. A. B., S. L. Da Silva, M. C. H. Tavares, N. V. Grosman, C. F. Cipreste, & P. H. G. Di Castro. 2010. Comportamento e bem-estar animal: o Enriquecimento Ambiental. In A. Andrade, M. C. R. Andrade, A. M. Marinho, & Ferreira-Filho, J. Biologia, Manejo e Medicina de Primatas não-humanos na Pesquisa Biomédica. Rio de Janeiro: Ed. Fiocruz.

Gonçalves, M. A. B., S. L. Da Silva, M. C. H. Tavares, N. V. Grosman, C. F. Cipreste, & P. H. G. Di Castro. 2010. Comportamento e bem-estar animal: o Enriquecimento Ambiental. In A. Andrade, M. C. R. Andrade, A. M. Marinho, & Ferreira-Filho, J. Biologia, Manejo e Medicina de Primatas não-humanos na Pesquisa Biomédica. Rio de Janeiro: Ed. Fiocruz.

GONÇALVES, M. A. B., S. L. DA SILVA, M. C. H. TAVARES, N. V. GROSMANN, C. F. CIPRESTE, & P. H. G. DI CASTRO. 2010. Comportamento e bem-estar animal: o Enriquecimento Ambiental. In A. Andrade, M. C. R. Andrade, A. M. Marinho, & Ferreira-Filho, J. Biologia, Manejo e Medicina de Primatas não-humanos na Pesquisa Biomédica. Rio de Janeiro: Ed. Fiocruz.

Gonyou, H. W. 1994. Why the Study of Animal Behavior is Associated with the Animal Welfare Issue. Journal of Animal Science, 72:2171-2177.

Guimarães, J. S. 2012. Avaliação do impacto da visitação sobre o comportamento de duas espécies de primatas, o bugo-ruivo Alouatta clamitans Cabreira, 1940 (Primates, Atelidae) e o macaco-prego Sapajus nigritus Kerr, 1792 [Hill, 1960] (Primates, Cebidae), no Zoológico Municipal de Canoas, Rio Grande do Sul, Brasil (Graduate dissertation). Universidade Federal do Rio grande do Sul, Porto Alegre.

Harmsen, B. J., R. J. Foster, S. C. Silver, L. E. Ostro, & C. P. Doncaster. 2011. Jaguar and puma activity patterns in relation to their main prey. Mammalian Biology, 76(3), 320-324.

HÖZTEL, M. J., & L. C. P. MACHADO FILHO. 2004. Bem-estar Animal na Agricultura do Século XXI. Revista de Etiologia, 6:3-15.

JAVOROUSKI, M. L., & S. A. BICALHA. 2007. A História do Zoológico Municipal de Curitiba (Graduate dissertation). Faculdade Padre João Bagozzi, Curitiba.

Leite, M. R. P. 2000. Relação entre a Onça-pintada, Onça-parda e Moradores Locais em Três Unidades de Conservação da Floresta Atlântica do Estado do Paraná, Brasil (Masters dissertation). Universidade Federal do Paraná, Curitiba. https://doi.org/10.1822/6/21789061.v12i1p154

Maia, C. M. 2009. Comportamento de Onça-Parda (Puma concolor), no Zoológico de Campinas, frente à visitação pública (Undergraduate dissertation). Universidade Estadual Paulista “Júlio de Mesquita Filho”, Botucatu. https://doi.org/10.18362/bjta.v6.i2.15

MALLAPUR, A. A. SNEHA, & A. WARAN. 2005. Influence of visitor presence on the behaviour of captive lion-tailed macaques (Macaca silenus) housed in Indian zoos. Applied Animal Behaviour Science, 94:341-352. https://doi.org/10.1016/j.appbeh.2005.02.012

MANTOVANI, J. E., & A. PEREIRA. 1998. Estimativa da Integridade da Cobertura Vegetal de Cerrado Através de Dados TM/ Landsat. Anais IX Simpósio Brasileiro de Sensoriamento Remoto, 1455-1466. https://doi.org/10.11606/t.21.2003.tde-29042004-165724

MASON, G., R. CLUBE, N. LATHAM, & S. VICKERY. 2007. Why and How Should we Use Environmental Enrichment to Tackle Stereotypic. Applied Animal Behaviour Science, 102:163-188. https://doi.org/10.1016/j.applan.2006.05.041

McPhee, M. E., & K. CARLESTEAD. 2010. The importance of maintaining natural behaviors in captive mammals. Wild mammals in captivity: principles and techniques for zoo management, 2:303-313.

MITCHELL, H., & G. HOWEY. 2005. Zoo research guidelines: studies on the effects of human visitors on zoo animal behaviour. BLAZA, London, UK.

MONROY-VILCHIS, O., V. URIOS, M. ZARCO-GONZÁLEZ, & C. RODRÍGUEZ-SOTO. 2009. Cougar and jaguar habitat use and activity patterns in central Mexico. Animal Biology, 59: 145-157. https://doi.org/10.11606/157075609x437673
Montanhá, J. C., S. L. Silva, & V. Boere. 2009. Comparison of Salivary Cortisol Concentrations in Jaguars Kept in Captivity with Differences in Exposure to the Public. Ciência Rural, 39:1745-1751. https://doi.org/10.1590/S0103-847820090500500089

Morgan, K. N., & C. T. Tromborg. 2007. Sources of stress in captivity. Applied Animal Behaviour Science, 102: 262-302. https://doi.org/10.1016/j.applanim.2006.05.032

Moyes, C. D., P. M. Schulze. 2010. Princípios de fisiologia animal, 2ª ed., Porto Alegre, Artmed.

Nova, C. B. 2010. Influência da Visitação Humana no Comportamento de Quatro Espécies de Mamíferos do Zoológico Municipal de Curitiba, Estado do Paraná (Undergraduate dissertation). Universidade Federal do Paraná, Curitiba. https://doi.org/10.21041/compa2019/v2pat140

Novo, S. D. S., & J. I. Santos. 2014. A influência do enriquecimento ambiental no comportamento dos leões (Panthera leo) no Parque Ecológico Voturú. Ceciliana, 6:17-20

Oih, F., & F. J. Van Der Staay. 2012. Animal Welfare: At the Interface Between Science and Society. Veterinary Journal, 192:13-19. https://doi.org/10.1016/j.tvjl.2011.05.019

Palomares, F., N. et al. 2018. Scraping marking behaviour of the largest Neotropical felids. PeerJ, 6: e4983. https://doi.org/10.7717/peerj.4983

Pereira, L. B., A. R. V. De Almeida, & A. F. Soares. 2009. Enriquecimento Ambiental para animais que vivem em cativeiros. IX REPEX, 1-3.

Pimentel, J. S. et al. 2009. Inquérito Sorológico para Toxoplasmose e Leptospirose em Mamíferos Selvagens Neotropicais do Zoológico de Aracaju, Sergipe. Pesquisa Veterinária Brasileira, 29:1009-1014. https://doi.org/10.1590/S0100-736x2009001200010

Robert, A. 2009. Captive breeding genetics and reintroduction success. Biological Conservation, 142: 2915-2922. https://doi.org/10.1016/j.biocon.2009.07.016

Sains, E. C. O. 2008. Enriquecimento Ambiental no Zoológico Municipal de Curitiba/PR (Undergraduate dissertation). Universidade Federal Do Paraná, Curitiba. https://doi.org/10.18226/21789961.v12i1p154

Sepúlveda, M. L. I. 2008. Parque Nacional la Campana: Estudio Etnográfico (Undergraduate dissertation). Facultad de Ciencias Sociales, Santiago de Chile.

Silva, R. O. 2011. Enriquecimento ambiental cognitivo e sensorial para onças-pintadas (Panthera onca) sedentárias em cativeiro induzindo redução de níveis de cortisol promovendo bem-estar (Masters dissertation). Universidade de Brasília, Brasília. https://doi.org/10.26512/2015.12.t.19945

Silveira, L. 2004. Ecologia Comparada e Conservação da Onça-pintada (Panthera onca) e Onça-parda (Puma concolor), no Cerrado e Pantanal (Doctoral dissertation). Universidade Federal de Brasília. https://doi.org/10.11606/t.2007-1.d.14052007-163226

Silverio, R. A. 2015. Efeito do enriquecimento ambiental nas respostas adrenocortical e comportamental de onças-pintadas (Panthera onca) em cativeiro (Masters dissertation). Universidade Federal do Paraná, Curitiba. https://doi.org/10.26512/2015.12.t.1 19945

Stanton, L. A., M. S. Sullivan, & J. M. Fazio. 2015. A standardized ethogram for the felidae: A tool for behavioral researchers. Applied Animal Behaviour Science, 173:3-16. https://doi.org/10.1016/j.applanim.2015.04.001

Szokalski, M. S., C. A. Litchfield, & W. K. Foster. 2012. Enrichment for captive tigers (Panthera tigris): Current knowledge and future directions. Applied Animal Behaviour Science, 139:1-9. https://doi.org/10.1016/j.applanim.2012.02.021

Vasconcellos, A. D. S. 2009. O Estímulo ao Forrageamento como Fator de Enriquecimento Ambiental para Lobos guaraí: Efeitos Comportamentais e Hormonais (Doctoral dissertation). Universidade de São Paulo, São Paulo. https://doi.org/10.11606/t.147.2009.ide-30112009-095524

Vidal, L. S., F. R. Guilherme, V. F. Silva, M. C. S. R. Faccio, M. M. Martins, & D. C. Bani. 2016. The Effect of Visitor Number and Spice Provisioning in Pacing Expression by Jaguars Evaluated Through a Case Study. Brazilian Journal of Biology, 76:490-504. https://doi.org/10.1590/1519-6984.22814

Wells, D. L. 2005. A note on the influence of visitors on the behaviour and welfare of zoo-housed gorillas. Applied Animal Behaviour Science, 93:13-17. https://doi.org/10.1016/j.applanim.2005.06.019

Zeilhofer, P., A. Cezar, N. M. Torres, A. T. A. Jácomo, & L. Silveira. 2014. Jaguar Panthera onca Habitat Modeling in Landscapes Facing High Land-use Transformation Pressure - Findings from Mato Grosso, Brazil. Biotropica, 46:98-105. https://doi.org/10.1111/btp.12074