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Caitlin Mack

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# Role of temperature and shade coverage on behavior and habitat use of captive African lions, snow leopards, and cougars

Caitlin Mack

## **Abstract**

Big cats are native to a wide variety of environments. Unfortunately, conservation is needed for many of these species, so a population is kept in zoos. Oftentimes, captive cats living in these zoos are not in their native climate, which can create unique challenges in animal husbandry and exhibit design. For this study, the African lions (*Panthera leo*), snow leopards (*Panthera uncia*), and cougars (*Puma concolor*) residing at the Cincinnati Zoo & Botanical Garden were observed in their outdoor enclosures from the public viewing area. I expected cats native to cold climates, such as the snow leopards, would be more active during periods of lower temperatures. They were observed on ten different days between September 2015 and February 2016, for a half hour each day, a total of fifteen observation hours, in temperatures ranging from 33°F to 73°F. Outdoor enclosures were diagramed and divided up into sections. A behavioral code was created with behaviors coded by letters. The cats' behavior

and position in their enclosures were recorded at every minute mark for thirty minutes. The big cats displayed cooling behaviors more frequently on warm days, primarily through seeking shade. Lions were observed more frequently in shaded portions of the exhibit during temperatures greater than 51°F. Temperature was found not to have a significant effect on the average activity levels. The activity levels and environmental preferences in cats appear to be influenced by both the climate they grew up in and their species' native climate. Both should be taken into consideration when designing habitats for big cat species in captivity.

## **Introduction**

Big cat species live in a wide array of ecosystems. As such, they have evolved different adaptations to live in these different environments, such as heat regulation. African lions (*Panthera leo*) are native to the hot, arid regions of Africa. They are classified by the International Union for Conservation of Nature (IUCN) as Vulnerable (Bauer et al, 2015). Snow leopards (*Panthera uncia*) are native to the alpine regions of Central and South Asia. They are classified as Endangered by the IUCN, which is more severe than vulnerable (Jackson et al, 2008). Cougars (*Puma concolor*) have a large species range from Canada to the tip of Chile. They are well adapted to deal with a variety of conditions. Because they have such a wide geographic range, they are classified by the IUCN as Least Concern (Nielsen et al, 2015).

Cat species in a zoological setting are often not kept in their native climate zone. This creates a challenge in exhibit design, especially in outdoor exhibits, as the needs of each cat species are different. Wild cougars tend to be solitary and were found to prefer lower elevation as the winter grew colder (Alexander et al. 2006). Lions, on the other hand, are social animals, with the need to reinforce their bonds through behaviors such as head rubbing (Matoba et al. 2013). Behavioral enrichment has been found to be beneficial for orphan lion cubs that were not been able to learn social behaviors from their mothers (Ncube and Ndagurwa 2010). Captive cougars (Maia et al. 2012) and snow leopards (Sulser et al. 2008) have been shown to

become less active during periods of construction or other noise. Sometimes the exhibit design may also affect the activity levels of cats through the creation of microclimates. Lions were found to spend more time in the shade on sunny, warm days, while tigers were more likely to engage in cooling behaviors such as solar radiation input and evaporative heat loss. (Young et al. 2013). This kind of information is important in order for big cats kept in captivity for conservation purposes to be able to live healthy, enriched lives.

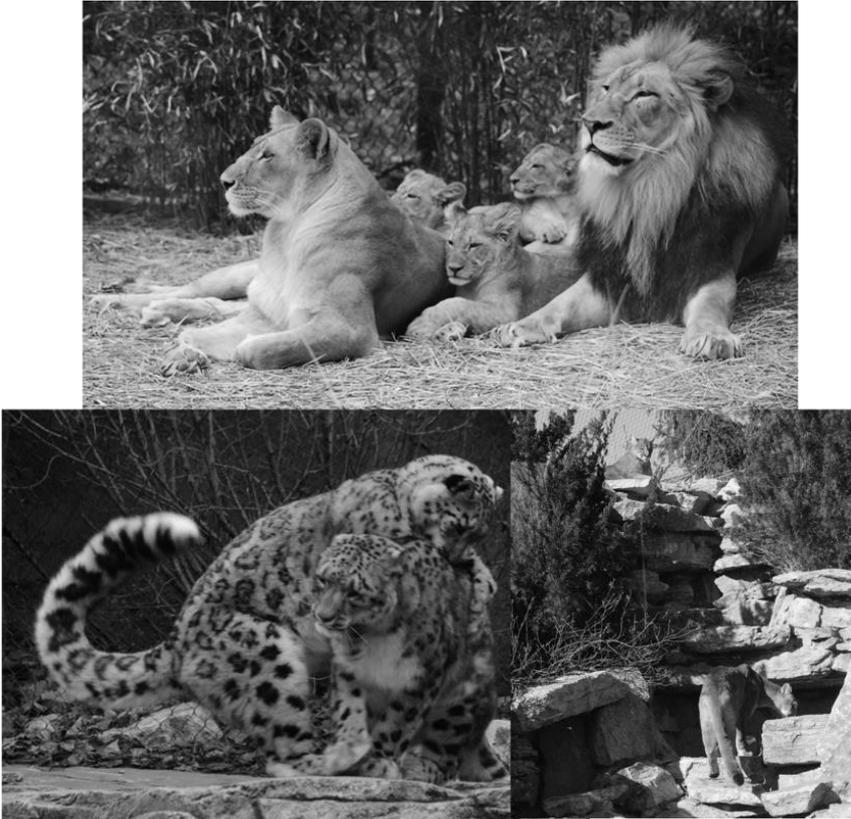
In this study, I observed differences in how three species of big cat, native to different environments, reacted to changes in their environment, specifically the effect of temperature and seasonal changes. I looked at this through observing frequency and type of activity and spatial preferences the cats exhibited within their enclosures. I hypothesized that snow leopards and lions would demonstrate the largest change in both activity levels and spatial preferences as the seasons changed. Cougars would remain the most constant. Snow leopards would become more active in the cold and lions will become more active in the heat. A scan sampling model was used in order to get an array of activity, since most cats species sleep most of the day.

## **Methods**

### *Subject and Enclosure Information*

All study subjects were residents of the Cincinnati Zoo. The zoo is located within a temperate climate with changing seasons. All study subjects were kept in outdoor enclosures while observations were being taken. The study subjects were two snow leopards , two cougars, and five African lions (Figure 1). The snow leopards were a young breeding pair. Their exhibit was oblong, with the elevation rising through the enclosure. The cougars were brothers. The cougars' exhibit contained a grassy area on one side with rocks and a cliff face at the other side. The lions consisted of a breeding pair with their three yearling female cubs. Their exhibit was mostly flat, with a slope going down to a water feature. All subjects had either been born and raised at the Cincinnati Zoo or had resided there for over one year.

All subjects were observed during their normal routines, with no interference from the observer.

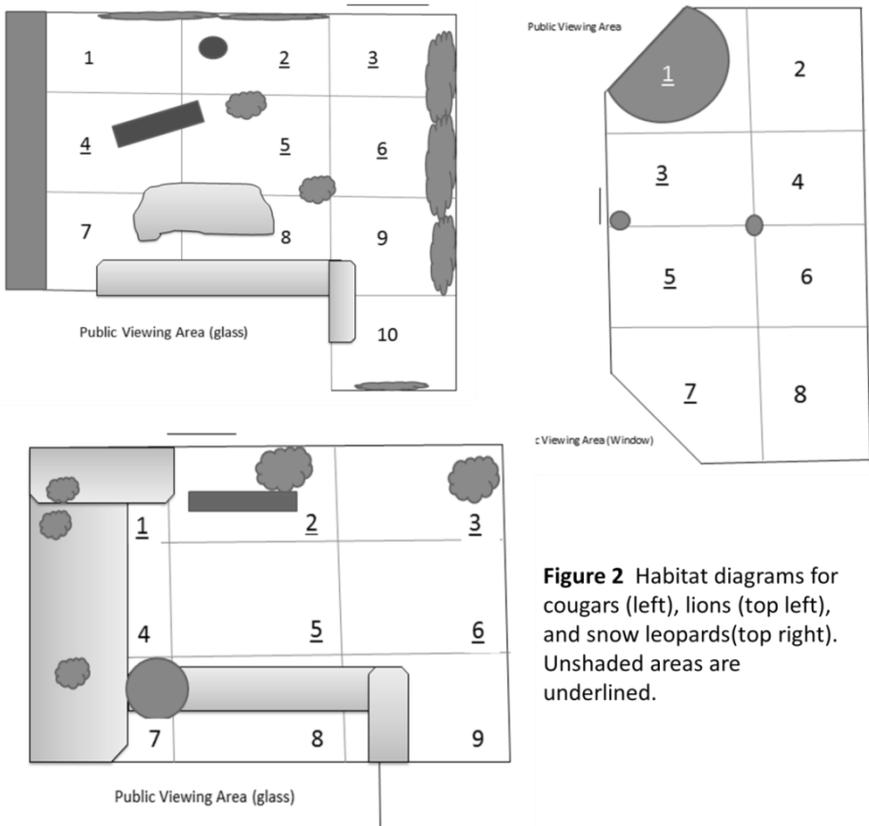


**Figure 1.** Study subjects: African lions, breeding pair and three female cubs (top); snow leopards, breeding pair (bottom left); cougars, brothers (bottom right)

### *Observation Methods*

Species were observed ten different days from late September 2015 through early February 2016. All observations were carried out somewhere between the hours of 9AM and 3PM, typically on the

weekend. All three species were observed for thirty minutes within the same day as the other species. The observer watched the cats from the public viewing area of each of their exhibits. Instantaneous scan sampling was used, with observations on activity type and animal location within enclosure recorded every minute. A shorthand code was created for each behavior type. Each behavior type was noted if an animal was doing more than one. The animal enclosures were divided up into sections, and these sections were noted every minute as well (Figure 2).



**Figure 2** Habitat diagrams for cougars (left), lions (top left), and snow leopards (top right). Unshaded areas are underlined.

### *Statistical Analysis*

An activity score was calculated for each cat based on ranking behavior categories in intensity of activity. These scores were averaged to find the average score for each cat species. A multiple regression analysis was performed using Wessa Regression Software for average activity score versus species, time of day, temperature, and time of year. An analysis was also performed for percentage of time spent in shade versus species, temperature, and sunshine and the interaction between temp & sunshine.

### **Results**

Cats were observed on ten occasions with the temperature ranging from 33°F to 73°F and cloud coverage ranging from completely sunny to fully cloudy days.

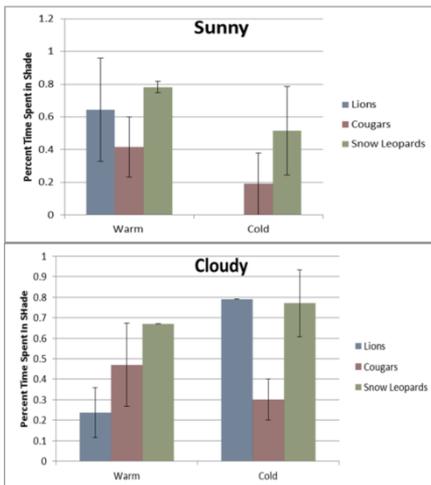
Lions were found to be less active than cougars and snow leopards ( $p < 0.05$ ) according to the average activity level of the three species. Multiple regression models looking at the effect of temperature, season, and time of day on average activity level yielded no significant results.

When looking at how the big cats used the natural variability in sun exposure in their exhibits, all three cat species were found to spend more time in the shade on days where the temperature was over 51°F (Fig. 3). Multiple regression showed a significant interaction between cloud coverage and temperature. The three big cat species spent most time in the shade on warm, sunny days with snow leopards spending more time in the shade than the lions and cougars (Table 1).

As temperatures got colder, the lions and cougars changed their preferred section of their exhibit. On warmer days, the lions preferred section 10, a shaded portion of their exhibit. On colder days, they spent more of their time in section 5, which is unshaded. The cougars preferred section 7, which is shaded, on warmer days and section 1, which is unshaded, on colder days.

**Table 1:** Multiple regression results with location in exhibit. Percentage of time spent in exposed areas of exhibit varied with cat species. More time was spent in exposed areas on cloudy days, especially when it was also colder.

Variable	Parameter	S.D.	2-tail p-value	1-tail p-value
(Intercept)	0.6045	0.3643	0.1095	0.05477
Lion & Cougar vs. Snow Leopard	-0.3182	0.1129	0.009271	0.004636
Temperature	0.002544	0.00662	0.7042	0.3521
Sunny	-1.505	0.5843	0.01629	0.008147
Interaction of Temperature & Sunny	0.02736	0.01083	0.01822	0.009112



**Figure 3:** Percent time spent in shade. The graphs to the left show percent of time spent in shade per species, depending on temperature and cloud cover. Cold days were defined as temperature 51° F or under. Warm days were temperatures greater than 51° F. All three cat species were indifferent to temperature on cloudy days, but responded to temperature on sunny days. This demonstrates the interaction between temperature and cloud coverage.

## Discussion

The results of this experiment support earlier studies. Another study looking at microclimates in captive tiger and lion exhibits found that lions spent more time in the shade on warm, sunny days versus other days (Young et al. 2013). There was evidence with these cats that both the native climate of their species and the environment with

which the individual cat is familiar influenced behavior. In support of the effect of native climate, the snow leopards were found in the shade more often than the cougars or African lions. This is possibly due to the snow leopards' thick coats, as compared to the other two cats. Since snow leopards evolved for the extreme cold of the mountains of Central Asia, they are built to retain any heat they can get. The evidence for the influence of the environment familiar to the individual was that all three species shared similarities in activity and shade-seeking. Also interesting was that the cougars and lions in this study changed their preferred habitat area as the weather changed.

Looking forward, this study gives evidence that in exhibit design, it is important to take into account the native climate of the species, the habitat variability tolerance of the species, and the climate with which the individual cat is familiar. One of the goals of exhibit design is to prevent stress behavior by providing enrichment. One way to do this is to provide diversity in shade and elevation within the habitat. For future research, it would be interesting to have a wider-ranging study using multiple zoos in various climates and environments and comparing results between them to see if the trends were similar between the different locations or if there are differences.

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