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# Gorilla-Visitor Interface at a Zoo Exhibit: Positioning Effects of Western Lowland Gorillas (Gorilla gorilla gorilla) and Zoo Visitors

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# GORILLA-VISITOR INTERFACE AT A ZOO EXHIBIT: POSITIONING EFFECTS OF WESTERN LOWLAND GORILLAS (*Gorilla gorilla gorilla)* AND ZOO VISITORS

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ABSTRACT

GORILLA-VISITOR INTERFACE AT A ZOO EXHIBIT: POSITIONING EFFECTS OF WESTERN LOWLAND GORILLAS (*Gorilla gorilla gorilla*) AND ZOO VISITORS

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Zoos have missions to provide high-quality care for their animals and an enjoyable and educational experience for visitors. Looking at the animal-visitor interface can allow zoos to evaluate their success in these efforts and to build upon what they have already accomplished. The present study was conducted to investigate the relationship between visitors and gorillas in a zoo environment. The effect of gorilla proximity to visitor viewing areas on visitor attentiveness was examined in indoor and outdoor gorilla exhibits. Visitor experience surveys were collected from visitors exiting the outdoor exhibit. Stepwise multiple regressions revealed group and individual gorilla proximity effects on visitor attentiveness. Analyses revealed that visitor attentiveness increased as gorillas got closer to the viewing area. A family group of seven gorillas and one individual gorilla, a silverback in the same family group, consistently changed positions in response to increases in crowd size, positioning themselves farther away from the viewing area. Visitors answered more positively to survey items concerning their perception of the zoo's gorillas when they also reported witnessing more active gorilla

behaviors and showed increased concern about gorilla conservation efforts when they spoke to an employee or volunteer about gorillas. Zoos can use this information to design enclosures that promote more active behaviors in their gorillas and limit visitor effects from crowd size. Zoos can also provide volunteers or employees who can discuss gorillas and conservation issues. Combined, these measures may help zoos succeed in their missions by allowing visitors to have more enriching experiences while limiting any negative effects on the gorillas.

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# CHAPTER I

# INTRODUCTION

Recently, zoos and researchers have become more interested in the effects that zoo visitors may have on zoo animals. Studies have shown that effects as a result of visitor stimuli can be present in groups or individual animals across many primate species (Blaney & Wells, 2004; Carder & Semple, 2008; Chamove, Hosey, & Schaetzel, 1988; Kuhar, 2008), but there is not a consensus on the predictability of these effects and they are still not fully understood. Numerous studies have also been conducted to assess how visitor behaviors and perceptions are affected by their experiences in animal exhibits (Bitgood, Patterson, & Benefield, 1998; Carr, 2016a; Hacker & Miller, 2016), but very few studies simultaneously look at both sides of the animal-visitor interface. To fully understand the relationship between visitor and animal, research should evaluate how animals react to visitors and how the visitors react to the animals they witness.

This study examined the impact of gorilla positioning within their enclosures on visitor attentiveness within the exhibit viewing areas and, then, how visitor positioning related to subsequent gorilla movement in their enclosure. It also investigated ways in which visitors' experiences in an outdoor gorilla exhibit altered their perceptions of the zoo's gorillas and conservation efforts for gorillas. Each of the goals of this study can be applied to one or more of the missions commonly shared by accredited zoos, such as providing top-level care for their animals, promoting educational and enjoyable experiences for visitors, and contributing towards conservation efforts.

# CHAPTER II

# LITERATURE REVIEW

## Overview of Zoos

According to the website for the Association of Zoos and Aquariums (AZA; AZA, 2017), an organization with a mission to help zoo animals thrive by advancing welfare, public engagement, and the conservation of wildlife, there are currently 214 AZA-accredited zoos and aquariums within the United States and 16 AZA-accredited institutions outside of the United States. These 230 organizations care for approximately 800,000 individual animals and 6,000 different species. According to the AZA, an estimated 195 million people visit their accredited institutions each year. Furthermore, AZA-accredited institutions contributed more than $22.5 billion to the U.S. economy in 2016, produced over 200,000 jobs within the U.S, and spent about $216 million each year in support of conservation projects, underscoring zoos' economic and conservation value (AZA, 2017).

## Gorillas in Zoos

The western lowland gorilla (*Gorilla gorilla gorilla*) is the only gorilla species found in North American zoos (The Gorilla Foundation, 2018). According to the website Gorillas Land, as of 2017, there were 957 western lowland gorillas in captivity worldwide, with 364 in North America, distributed among 53 different organizations (Gorillas Land, 2017). Carr (2016a) surveyed zoo visitors and found that gorillas were the most preferred animals for visitor viewing, with Sumatran orangutans (*Pongo abelii*) reportedly the second most popular animal. These two ape species were ahead of 50 other animals, including maned wolves (*Chrysocyon brachyurus*), spectacled bears (*Tremarctos ornatus*), and komodo dragons (*Varanus komodoensis*). One of the most reported reasons for visitor selections of a favorite animal was that gorillas and orangutans were more human-like; a not unreasonable perception given that gorillas possess a genomic divergence of 1.62% from humans (Chen & Li, 2001), indicating genetic similarity. Carr's (2016a) study indicates that for zoos, gorillas are likely to be a flagship species, potentially attracting greater numbers of visitors than other zoo animals.

**Visitor Effects on Zoo-Housed Non-Primate Animals**

Some research has shown that zoo visitors, via crowd size or noise, can negatively impact zoo animals at the group or individual level. In non-primate species, increased crowd size has been shown to increase behavioral and physiological indicators of stress (Scott, Heistermann, Cant, & Vitikainen, 2017; Stevens, Thyseen, Laevens, & Vervaecke, 2013). Stevens et al. (2013) investigated the impact of daily visitor attendance on harbor seal (*Phoca vitulina*) behavior and found that higher visitor attendance was associated with seals spending more time submerged underwater, which was presumed to be a method of visitor avoidance, as well as less time visually scanning their surroundings and resting on land. Scott et al. (2017) found that meerkats (*Suricata suricatta*) had higher fecal glucocorticoid levels, a determinant of stress levels, when median visitor numbers increased in the days before the fecal collections but lower glucocorticoid levels when visitor numbers fluctuated more throughout the prior day.

In addition to visitor crowd size, noise level has been evaluated for potential negative impacts on zoo animals (Owen, Swaisgood, Czekala, Steinman, & Lindburg, 2004; Quadros, Goulart, Passos, Vecci, & Young, 2014; Sulser, Steck, & Baur, 2008). Sulser et al. (2008) found that noise from a nearby construction site affected the behavior and space use of snow leopards (*Panthera uncia*). On days with construction noise, snow leopards spent less time in locomotion, used less of their exhibit, and spent more time in their remote off-exhibit enclosure than they did on days without construction noise, suggesting that noise from the construction caused the snow leopards to limit their use of the exhibit. Owen et al. (2004) found that days with higher levels of ambient noise were associated with an increase in giant panda (*Ailuropoda melanoleuca*) locomotion, self-scratching, vocalizations suggestive of agitation, and restless manipulation of the enclosure's exit door; all of which were considered stress responses in that species. Days of high noise levels were also associated with increased glucocorticoid levels in the pandas' urine, a hormonal indicator of increased stress (Owen et al., 2004). Quadros et al. (2014) found that visitor crowd noise affected behavior in zoo animals from seven non-primate species on an individual level, with movement and/or vigilance increasing in affected individuals during days of higher noise level. Some species were also affected on a group level, with red deer (*Cervus elaphus*) increasing vigilance, and giraffes (*Giraffa camelopardalis*) and bush dogs (*Speothos venaticus*) increasing movement, on noisy days.

While many studies have identified negative visitor effects at zoo exhibits, a select few have suggested enriching effects of visitor presence. In a study looking at Asian short-clawed otters (*Aonyx cinerea*), the otters were found to increase feeding, foraging, and play behaviors in the presence of visitors (Owen, 2004). Nimon and Dalziel (1992) identified that an individual long-billed corella (*Cacatua tenuirostris*) spent a vast majority of its time in the front area of its enclosure, presumably looking for visitors. However, the same long-billed corella was shown to retreat from the front of its exhibit on days when the zoo was very busy, such as weekends or holidays. This indicates that visitors may have an enriching effect on a zoo animal, but there also could be a threshold at which these enriching effects may become negative. Overall, there are many more studies that indicate negative visitor effects on zoo animals than studies indicating positive effects, but positive effects have been identified.

**Visitor Effects on Zoo-Housed Primates**

A large number of studies investigating visitor effects have focused on zoo-housed primates but disparate findings among studies have limited the ability to form a consensus on the impact visitors have on primates. While numerous studies indicate that larger crowds can contribute to elevated levels of stress behaviors for many different primates (Blaney & Wells, 2004; Carder & Semple, 2008; Chamove et al., 1988; Kuhar, 2008; Stoinski, Jaicks, & Drayton, 2012; Wells, 2005), there are also studies that suggest that, for some species or individuals, larger crowds may be enriching (Bloomfield, Gillespie, Kerswell, Butler, & Hemsworth, 2015) or have no discernable behavioral effect (Hosey et al., 2016; Smith & Kuhar, 2010).

Kuhar (2008) found that gorillas make themselves less visible when larger visitor groups are present and that a bachelor group, but not a family group, displayed more aggression in the presence of larger visitor crowds. This suggests that some visitor effects may be sex-specific or expressed at an individual level for gorillas, corroborating findings by Stoinski et al. (2012) that while visitor effects can have a negative impact on captive gorilla welfare, it may only apply to certain individuals or groups and not for the species as a whole. Carder and Semple (2008) investigated the Port Lympne and Chessington Zoos to determine crowd size effects on gorilla stress behaviors such as self-scratching and visual monitoring. The authors found that the presence of crowds at Port Lympne Zoo resulted in more stress behaviors among gorillas but had no effects at Chessington Zoo. The authors theorized that the observed differences may have been due to the larger visitor numbers at Port Lympne Zoo than at Chessington Zoo. Alternatively, Chessington Zoo did not have a silverback during the study's duration, causing Carder and Semple (2008) to postulate that group composition may have contributed to differences in behavioral responses between sites. Of significance to other studies on visitor effects, Carder and Semple (2008) also found that crowd size did not alter stress behavior when feeding enrichment was present and the gorillas were foraging, leading to the suggestion that feeding enrichment may attenuate visitor effects.

Wells (2005) found that, during days of high visitor numbers, gorillas spent less time resting and displayed significantly more conspecific-directed aggression and stress behaviors such as auto-grooming and abnormal behaviors. Chamove et al. (1988) found that Diana monkeys (*Cercopithecus diana*), cotton-top tamarins (*Saquinus oedipus*), and ring-tailed lemurs (*Lemur catta*) all increased agonistic behaviors and decreased inactivity and grooming when crowds of six or more visitors were present. Interestingly,when a camouflage net was placed as a barrier between a gorilla enclosure and the public viewing area, decreases in stereotypic behaviors and conspecific-directed aggression were observed in the gorillas while visitors simultaneously perceived the gorillas as more exciting and less aggressive (Blaney & Wells, 2004). Visitors also viewed the exhibit containing the camouflage net as more appropriate for the general public, reporting via survey that the net could be beneficial for both gorillas and visitors due to the more natural feel it provided.

Bloomfield et al. (2015) covered half of an orangutan exhibit's viewing window to investigate if the orangutans preferred to position themselves within their enclosure so that they were visible or not visible to the public. The cover was alternated from side-to-side during the duration of the study, and regardless of which side was covered, the orangutans spent 75% of their time on the side visible to visitors, suggesting that visitor presence had an enriching effect on the orangutans. Hosey et al. (2016) studied chimpanzee (*Pan troglodytes*) and ring-tailed lemur wounding aggression frequencies at different zoos, using records dating back to 1999, and found no differences in wounding frequency between days of low and high visitor numbers. However, their results were limited as the authors only included woundings that were significant enough to require veterinary treatment and did not consider other potential measures of aggression. Smith and Kuhar (2010) found no correlation between visitor number and stress behavior frequency in siamangs (*Symphalangus syndactylus*) and white-cheeked gibbons (*Nomascus leucogenys*); however, individuals of both species positioned themselves significantly further from crowds on busier days and, while there was no significant difference in visibility due to zoo attendance levels, gibbons did tend to be less visible during days of higher attendance.

As with non-primate species, there is little research on sound level effects on captive primates, but some findings suggest that higher noise levels can negatively affect primate well-being. For reference, according to the National Institute for Occupational Safety and Health (1998), an acceptable sound level for humans over an eight-hour period is 85 decibels (dBA), with the timeframe being halved for every 3 dBA increase. Additionally, 60 dBA is considered a comfortable noise level for humans and is the level of a standard speaking conversation. For gorillas, a species whose auditory system is poorly known, it is recommended that noise be controlled for the range of human hearing (AZA Gorilla Species Survival Plan, 2017).

Birke (2002) found that both adult and infant orangutans spent more time looking at visitors in noisy conditions than in quiet conditions. Adults also spent more time sitting during noisy conditions than in quiet conditions, while infants approached and were in contact with their mothers more in the noisy conditions, indicating age-dependent behavioral effects of visitor noise. Cooke and Schillaci (2007) found that noise level affected the behavior of white handed gibbons (*Hylobates lar*) at two different zoos, with gibbons exposed to higher noise levels increasing the amount of time spent looking at visitors, looking at their mate, and opening their mouths, while decreasing time spent hanging and climbing. Quadros et al. (2014), also studied the effects of crowd noise on western lowland gorillas, chimpanzees, brown howler monkeys (*Alouatta guariba*), golden-headed lion tamarins (*Leontopithecus chrysomelas*), and yellow breasted-capuchins (*Sapajus xanthosternos*).

As noted previously, Quadros et al. (2014) found that noise effects were expressed at an individual level and at a group level for only some species. For example, in noisier conditions an individual gorilla increased vigilance, a group of yellow-breasted capuchins increased vigilance, and a group of golden-headed lion tamarins increased both movement and vigilance. Quadros et. al. suggested the presence of a positive feedback cycle between zoo visitors and animals in that visitors prefer more active animals (Carr, 2016b), resulting in more crowd noise that may further increase animal activity. Then, more animal activity may lead to a noisier crowd, causing a positive feedback cycle. Thus, more studies should investigate potential reciprocal effects between visitor crowd and animal behavior to better understand if this positive feedback cycle occurs.

## Animal Proximity and Behavioral Effects on Visitors

Specific aspects of viewing zoo animals have been shown to alter visitors' perceptions of the care given to those animals, their knowledge and opinions of different species and their conservation, and how favorably visitors respond to their experience. For example, Bitgood et al. (1988) found that visitors stay longer in exhibits when the exhibit's animals are more visible and that visitors were more likely to stop at the exhibit if the animals were closer to the viewing area. These findings indicate that increased animal distance from the viewing area and decreased visibility of animals in their enclosures could result in smaller crowds forming due to shorter viewing times and fewer visitors stopping at the exhibit. In Carr's (2016a) survey of zoo visitors' favorite and least favorite zoo animals, the most common reason given for rating an animal as least favorite was that it was not visible enough for the visitor's liking. Hacker and Miller (2016) surveyed visitors after an experience viewing an elephant (*Elephas maximus, Loxodonta africana*) exhibit and found that those visitors who reported experiencing an up-close encounter with the elephants had significantly higher intent to perform conservation-related behaviors and also attributed more value to the importance of elephants in the wild than did those visitors who did not experience an up-close encounter.

Along with proximity and visibility, an animal's behavior can impact visitor experiences. In the study by Hacker and Miller (2016) noted above, visitors who reported seeing a wider variety of active elephant behaviors had higher conservational intent and attributed more value to elephants in the wild than did visitors who did not report seeing a variety of active elephant behaviors. Luebke, Watters, Packer, Miller, and Powell (2016) surveyed visitors exiting zoo exhibits and found that up-close encounters with animals as well as a variation in observable behaviors, predicted visitors' positive emotional responses to an exhibit. In another study, Miller (2012) showed visitors videos of either a tiger (*Panthera tigris*) pacing in its exhibit or of a tiger performing species-typical behaviors. Visitors that viewed the pacing video reported lower opinions of zoo animal care and welfare, as well as lower ratings for the importance of zoos, than did visitors who watched the video of species-typical behaviors, indicating that visitors may be capable of identifying stereotypic behaviors in zoo animals. The findings that active behaviors positively affected visitor zoo perceptions and that visitors could identify stereotypic behaviors suggests that promoting both active and species-typical behaviors may improve the visitor experience.

**Rules and Regulations for Zoo Exhibits**

Both public and private organizations within the United States provide regulatory oversight for care and safety precautions to be undertaken by zoo personnel. These organizations include the United States Department of Agriculture (USDA) and the AZA, which provides a multitude of species-specific species survival plans (SSP). The USDA is the only mandatory licensing agency for zoos, enforcing the Animal Welfare Act (AWA; United States Congress, 1966), which is the only federal law in place to standardize the care and treatment of all animals within the United States that are bred for commercial sale, used in research, transported commercially, or exhibited to the public.

The AZA is a non-profit, member-driven organization designed to facilitate the advancement of zoos and aquariums in conservation, education, science, and recreation. The staff of approximately 230 AZA-accredited institutions within the United States and overseas follow standards of care outlined by the AZA. There are no laws requiring zoos or aquariums to follow the rules of the AZA because accreditation is voluntary; however, many zoos strive to comply with AZA protocols, because staff believe in providing the best standards of care and AZA accreditation is typically perceived as an identifier of an ethically-run zoo. Overall, less than 10 percent of wildlife exhibitors licensed by the USDA under the AWA meet the standards of AZA accreditation (AZA, 2019). The AZA manages multiple species survival plans (SSP), which are designed to oversee the population management of numerous species and maximize their genetic diversity within AZA-accredited institutions with the ultimate goal to maintain population sustainability for ex-situ conservation. An SSP also helps to organize species-specific guidelines for husbandry, management, research, and educational or conservation initiatives (AZA, 2014). There are currently over 450 SSP programs in place, including SSPs for gorillas, chimpanzees, orangutans, and many other primate species.

Beyond safety and zoonotic disease transmission, there are currently no regulations from the USDA and AZA specifically regarding the mitigation of visitor effects, likely because visitor effects have only recently begun to be studied in detail and consistent predictable effects have not been identified. The AWA does not specifically mention visitor effects in its sections on the care and handling of any animals, including nonhuman primates. The AWA does state that a fixed public exhibit must have a physical barrier between the animal enclosure and the public viewing area, enough to completely prevent physical contact between the two sides. However, no mention is made of efforts required to mitigate effects of potential stressors to the nonhuman primates, such as noise or crowd size. The 2019 AZA accreditation standards also do not directly address visitor effects but do mention that animal enclosures must meet an animals' physical and psychological needs, and that the animals must be protected or provided accommodation from weather or other conditions clearly known to be detrimental to the animals' health or welfare. Additionally, noise level monitoring has recently become a more common strategy for welfare assessment in zoo animals.

While the AWA and AZA literature do not specifically mention visitor effects as a condition that could negatively affect the health or psychological needs of animals, visitor effects may fall within that category by contributing to increases in stress or aggression. SSPs are tasked with creating species-specific regulations for the care of zoo animals, which allows for a more in-depth assessment of the particular needs of a species. The gorilla care manual (AZA Gorilla Species Survival Plan, 2017) identifies visitor noise as a potential stressor for zoo-housed gorillas, citing multiple studies to support this concern (Birke, 2002; Cooke & Schillaci, 2007; Kuhar, 2008). It also provides suggestions for methods to dampen sounds and vibrations, such as using substrates or materials that can either absorb noise or cause less noise.

There are currently 27 different AZA animal care manuals, all of which have a section outlining the importance of managing sound and vibration to promote quality of life. The gorilla care manual also suggests the use of visual barriers and providing animals access to privacy in order to reduce stress, which could be interpreted as providing visual privacy from either conspecifics or visitors. Most AZA animal care manuals do not mention potential effects of visitor crowd density, but the chimpanzee and jaguar (*Panthera onca*) manuals touch on the negative effects that crowd size could have, referencing species-specific studies (AZA Ape TAG, 2010; AZA Jaguar Species Survival Plan, 2016; Chamove et al., 1988; Sellinger & Ha, 2005; Wood, 1998).

**Use of Space by Zoo-Housed Gorillas**

In addition to external factors such as noise or crowd size, a gorilla's environment may impact how the animal chooses to orient itself within its enclosure. Ross, Calcutt, Schapiro, and Hau (2011) found that gorillas in a naturalistic exhibit at the Lincoln Park Zoo positioned themselves near corners and permanent elements in the enclosure such as solid, climbable structures that were not moveable. This may have been due to those elements providing a less open or vulnerable state, as gorillas in that study also spent less time in open areas or near water sources and temporary elements (e.g., climbable structures that are moveable or changeable) than would be expected given those features' proportion of space within the enclosure. This study suggests that gorillas have preferred areas within their enclosures and that such enclosures could be designed to allow gorillas a greater diversity of preferred spaces.

Knowledge of preferred elements within an enclosure, as well as an understanding that visitor noise or crowd size may affect gorillas, can be used in exhibit design to balance proximity to and visibility of gorillas for visitors while also meeting the needs for optimal gorilla well-being. In a follow-up study to Ross et al. (2011), Bonnie, Ang, and Ross (2016) investigated the effects of crowd size on both space use and gorilla behavior in the newly constructed enclosure at the Lincoln Park Zoo and found no differences in space use, agonism, or attention to visitors in the presence of larger crowds, suggesting that enclosures specifically designed to accommodate gorilla space-use preferences may mitigate potentially adverse effects of visitor crowds.

## Roles of Zoos in Education and Conservation

Providing the public with an educating and enriching experience is a primary mission of AZA-accredited zoos in the United States, along with promoting research and conservation efforts. For instance, the San Diego Zoo's mission statement is a commitment to "saving species worldwide by uniting our expertise in animal care and conservation science with our dedication to inspiring passion for nature" (San Diego Zoo, 2018). The Cincinnati Zoo and Botanical Gardens' (CZBG) mission statement indicates that they are "dedicated to creating adventure, conveying knowledge, conserving nature, and serving the community" (CZBG, 2018). To enhance the experience for visitors, many zoos have educational signage or interperetive activities to help visitors learn about animals. In addition, visitors may experience emotional connections to the animals they observe, which in turn may result in greater conservation awareness.

Visitors report experiencing certain emotions, particularly positive ones such as respect and wonder, in response to observing some animal exhibits (Myers, Saunders, & Birjulin, 2004). Perkins (2010) found that a person's emotional disposition towards nature was related to pro-environmental behaviors and their willingness to sacrifice from their own lives to protect the environment. Luebke et al. (2016) reported that positive emotional responses while observing an exhibit could predict visitors' meaning-making, which was defined as how much the exhibit made conservation issues more meaningful to them (Luebke et al., 2016, p. 65). These findings indicate that a zoo visit can increase visitors' conservation awareness and intention, contributing to a zoo's mission to enhance conservation efforts.

McCarthy and colleagues (2012) estimate that the annual cost of protecting and managing all of the world's endangered and threatened species is around 76.1 billion USD.

As noted earlier, about 216 million USD a year is spent by AZA-accredited institutions in support of conservation projects, but there are significantly more zoos and aquariums worldwide that contribute even more to conservation efforts. Additionally, if positive emotional experiences at zoos promote pro-environmental behaviors and meaning-making (Perkins, 2010; Luebke et al., 2016), I argue that zoos and aquariums could also impact the willingness of visitors to donate to conservation organizations after their zoo visit, given that Lindemann-Matthies and Kamer (2005) have shown that visitor learning in a zoo exhibit can be retained at least two months after a visit.

**Surveying Zoo Visitors**

Zoo visitor surveys can help identify aspects of a visitor's experience that have the greatest effect on their levels of enjoyment, learning, and conservational intent (Blaney & Wells, 2004; Carr, 2016a; Hacker & Miller, 2016; Luebke et al., 2016; Luebke & Matiasek, 2013; Lukas & Ross, 2005; Reade & Waran, 1996; Woods, 2002). Such studies can also provide an assessment method for zoos to evaluate their mission goals related to conservation efforts, public education, and enjoyment. For example, Hacker and Miller (2016) surveyed visitors after leaving the viewing area of an elephant exhibit and found that visitors' conservational intent increased when they self-reported up-close encounters with the elephants, witnessed diversity in the elephants' behavior, and witnessed active behaviors such as walking, playing, and dust-bathing.

As previously noted, the importance of animal activity on visitor perceptions was also demonstrated by Carr's (2016a) survey asking zoo visitors to rate their favorite and least favorite animals. Carr found that commonly reported reasons for selecting a favorite animal were how amusing or entertaining the animals were, the presence of infants, and how active the animals were. In contrast, some of the most common reasons for an animal to be selected as least favorite were that the animal was not visible or was hard to see, that the animal looked frightening, and that bad smells came from the exhibit. Woods (2002) surveyed visitors on their best and worst experience with wildlife, either in captive or natural settings, and found that the most common positive experiences in captive environments involved interactions with animals and the opportunity to learn about the animals. In contrast, the most common negative experiences were how the visitors perceived the management of the animals by the zoo, aggressive behaviors observed in the animals, and poor management of human-wildlife interaction (Woods, 2002). These types of findings indicate that surveys of zoo visitors not only allow zoos to evaluate the extent and types of impacts their exhibits have on each visitor's environmental knowledge and awareness, but also allow zoo administration to identify exhibit elements that could be improved from a visitor's perspective.

In most surveys involving visitors' experiences at an exhibit, the survey participants are encountered as they leave the exhibit's viewing area (Hacker & Miller, 2016; Luebke et al., 2016; Luebke & Matiasek, 2013; Lukas & Ross, 2005), which allows for immediate recollection of experiences, but may not provide an accurate assessment of long-term impacts. Research has found that zoo visitors retain information gained from their exhibit experiences two months later (Lindemann-Matthies & Kamer, 2005), suggesting that long-term impacts are possible. There may also be limitations in the representativeness of survey participants because data can only be collected from visitors who agree to take the survey, resulting in a potential self-selection bias, although approaching individuals at random to complete the survey may limit the impact of self-selection bias. Social desirability bias may affect answers to questions regarding conservation, as individuals may be more inclined to self-report themselves in a manner that would be viewed more favorably by others. Lastly, time constraints may limit survey participation and/or completion. For example, Lukas and Ross (2005) found in a pilot study that 35% of 119 individuals approached agreed to respond to their survey, with 53% of the non-respondents citing time constraints.

**Study Goals and Hypotheses**

My goals in this study were to investigate gorilla proximity to visitors, its potential effect on visitors' attentiveness, and, then, subsequent changes in gorillas' movements in their enclosure which might, in part, be due to visitor effects. I examined the potential impact of gorilla positioning in their enclosure on visitor crowd size, crowd density, crowd noise, and visitor focus in the most popular visitor viewing areas. Then, to assess potential gorilla-visitor reciprocal effects, I evaluated the changes in gorilla positioning within their enclosure against crowd size, crowd density, crowd noise, and visitor focus. Thus, this study was intended to delineate a behavioral feedback loop between zoo gorillas and visitors in the viewing area of the exhibit. As a secondary goal, I surveyed visitors as they exited the viewing area of the exhibit in order to assess the types of gorilla behaviors visitors witnessed, and their attitudes towards conservation and gorillas in zoos. I hypothesized that differences in gorilla proximity to the visitor viewing areas would cause a change in visitor crowd size, density, noise, and visitor focus. I also hypothesized that crowd size, density, noise, and visitor focus would cause a change in gorilla proximity to the visitor viewing area. Lastly, I hypothesized that gorilla proximity to the visitor viewing areas and the number of visitor-reported active behaviors would cause differences in visitors' attitudes towards gorillas and zoos, as well as towards gorilla conservation.

I had four predictions for this study: 1) Gorilla proximity to the visitor viewing area would cause an increase in crowd size, crowd noise, and visitor focus; 2) increased crowd size, crowd noise, and visitor focus would cause gorillas to distance themselves from the visitor viewing area; 3) gorilla proximity to the visitor viewing area would improve visitor attitudes and perceptions toward conservation, gorillas, and zoos; and 4) higher numbers of active gorilla behaviors observed by visitors would improve visitor attitudes and perceptions toward conservation, gorillas, and zoos.

# CHAPTER III

# METHODS

## Participants

**Gorillas.** Ten western lowland gorillas (*Gorilla g. gorilla*) housed in the Gorilla World area of the CZBG in Cincinnati, OH, were observed. The gorillas were divided into three social groups, hereafter designated as the family group, the female group, and the solo silverback. The family group consisted of seven individuals, including one adult male (26 years old), three adult females (48, 37, and 22 years old), and three juvenile females (5, 3, and 2 years old). The female group had two adult females (22 and 15 years old). The solo silverback (30 years old) was kept alone during the course of the study due to preparation for introduction to the female group. To maintain a dynamic experience for the gorillas and to mitigate their anticipation of patterns in shifting exhibits, animal care staff randomized the schedule that gorilla groups would occupy various exhibits and holding locations.

**Zoo Visitors.** Zoo visitors to the Gorilla World section of the CZBG were included in this study in two ways. Firstly, all visitors present in the viewing areas of the outdoor and indoor gorilla exhibits were periodically observed to determine their location in the viewing area and if their vision was oriented toward the gorilla enclosure. As a result, data on the total number of visitors in the viewing area were also collected along with the maximum and average sound level in the visitor area (in decibels). Only visitors who stopped in exhibits' viewing areas were counted. Secondly, I approached every fifth zoo visitor who looked over the age of 18 who walked through the exit of the outdoor gorilla exhibit viewing area and into the entrance of the indoor exhibit viewing area to ask them to participate in my zoo visitor experience survey. Multiple members of the same visitor group were not approached.

Visitor experience surveys were only distributed at the exit of the outdoor exhibit because the Gorilla World pathway required visitors to view the outdoor exhibit before the indoor exhibit and data collected at the indoor exhibit would, therefore, have been influenced by the outdoor exhibit. If an individual younger than 18 years old was mistakenly approached and completed a survey, that survey was not included in data analysis.

Ninety-eight surveys were collected across viewing days (Family Group: $n$ = 32, Female Group: $n$ = 33, and Solo Silverback $n$ = 33). As indicated by Table 1, the majority of respondents were women, people between 26 to 40 years of age, and non-zoo members.

Table 1

*Demographic Information for Visitor Experience Survey Respondents (n = 98)*

| Information | Response | Percent Represented ($n$) |
|---|---|---|
| Gender | Male | 36.7% (36) |
| | Female | 61.2% (60) |
| | No Response | 2.0% (2) |
| Age | 18-25 years old | 7.1% (7) |
| | 26-40 years old | 43.9% (43) |
| | 40-55 years old | 27.6% (27) |
| | 56+ years old | 20.4% (20) |
| | No Response | 1.0% (1) |
| Zoo Member | Yes | 42.9% (42) |
| | No | 54.1% (53) |
| | No response | 3.1% (3) |
| Talked with Employee | Yes | 28.6% (28) |
| or Volunteer | No | 66.3% (65) |
| | No Response | 5.1% (5) |

## Materials

**Study Site.** This study was conducted in the Gorilla World section of the CZBG. The Gorilla World area consisted of a trail that split directly from the main pathway of the CZBG. There were two gorilla exhibits within this area, an outdoor and an indoor exhibit. The outdoor exhibit was the first of the two gorilla exhibits that guests encountered after entering Gorilla World, with the indoor gorilla exhibit located immediately after. The outdoor gorilla enclosure contained plant material, rock formations, a small stream, two waterfalls and a large artificial tree placed on its side for climbing. The enclosure was approximately 37 meters by 11 meters with a moat in front of the exhibit providing approximately 4.5 meters of separation between the gorilla area and the visitor viewing area. The visitor viewing area of the outdoor exhibit was split into three sections for data collection. The visitor-left section (i.e., when facing the exhibit) was 13.1 meters wide, the visitor-middle section was 13.7 meters wide, and the visitor-right section was 6.9 meters wide.

The indoor exhibit was positioned immediately after the outdoor exhibit with visual barriers in place to prevent the gorillas in the outdoor and indoor exhibits from being visible to one another and preventing the public from viewing both exhibits at once. The indoor gorilla enclosure contained a mulch substrate with rock formations and large artificial trees that provided vertical access for the gorillas in the back half of the enclosure. The indoor enclosure was approximately 24 meters by 11 meters with glass windows separating the enclosure and the visitor viewing area. The visitor viewing area for the indoor exhibit was also split into three viewing areas for data collection. The visitor-left section of the viewing area was 5.9 meters wide, the visitor-middle section was 7.0 meters wide, and the visitor-right section was 3.7 meters wide. A diagram of both exhibits and viewing areas can be found in Appendix A.

The gorilla space of the outdoor exhibit was split into six different sections for gorilla location scanning purposes, with front and back halves of the enclosure that were further delineated into left, center, and right thirds. Each quadrant was irregular in shape, but was approximately 67.8 square meters. See Appendix B for a detailed diagram of the quadrant designations. The indoor enclosure was also split into six front-back, left-center-right sections with each section approximately 44 square meters. In contrast to the outdoor exhibit, the indoor exhibit included vertical space for the gorillas to position themselves in the back half of the enclosure, two meters or more above the bottom of the enclosure. Therefore, the indoor exhibit included an additional three vertically-elevated areas, resulting in a total of nine sections. A diagram of the indoor enclosure divided into sections can be found in Appendix C.

**Sound Level.** A 3M SE-402 Sound Examiner Sound Level Meter, a class two microphone, was used to measure average noise level, elapsed time, maximum noise level, and minimum noise level. The sound level meter was used at the center of both the indoor and outdoor exhibit visitor viewing areas to measure the maximum and mean decibel levels for each scan sample.

**Visitor Experience Survey.** The visitor experience survey was based, in part, upon a visitor experience survey by Hacker and Miller (2016) designed to examine zoo visitors' reactions to their experiences viewing an elephant exhibit. As constructed for this study, the survey had six sections to detail the self-reported experiences of the visitor as well as their backgrounds. Those six sections included: 1) A list of 13 active and inactive gorilla behaviors that the visitor could use to indicate which behaviors they personally observed during their viewing of the exhibit, with active behaviors involving the movement of a gorilla's body or limbs; 2) four items to evaluate visitor beliefs about the zoo's gorillas rated using a 6-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*; see Table 2); 3) four items to evaluate visitors' perceptions towards gorilla conservation efforts using the same 6-point Likert scale as in section two (see Table 2); 4) a question asking if the visitor was more likely to donate his or her money, donate his or her time, or to change his or her lifestyle to benefit the environment; 5) a question asking which section of the visitor viewing area the visitor spent the majority of his or her time; and 6) demographic information including age, gender, whether the visitor was a zoo member, and whether the visitor spoke to an employee or volunteer about gorillas. The survey is presented in its entirety in Appendix D.

Table 2

*Visitor Experience Survey Items Rated on 6-point Likert Scales from 1* (*Strongly Disagree*) *to 6* (*Strongly Agree)*

| |
|---|
| The zoo's gorillas seem happy and healthy. |
| The zoo's gorillas seem well cared for. |
| I feel a closer connection to gorillas after viewing this exhibit. |
| I am concerned about gorillas' conservation status in the wild. |
| I am going to discuss gorilla conservation with my friends. |
| I am going to change some of my daily activities to benefit the environment. |
| I am going to find out more about the zoo's conservation efforts. |
| I am going to support the zoo's and/or other organizations' conservation efforts. |

## Procedure

**Scan Sampling and Sound Level.** The study was conducted over a one-month period in July of 2018. Data were collected Monday through Friday on days when expected total visitor numbers of the CZBG did not exceed 12,000. To ensure that gorilla foraging did not affect the study (Carder & Semple, 2008), data collection began at 10:00am, an hour after the gorillas have been given access to their exhibit and morning meal. In addition, to minimize effects of keeper presentation on visitors' experiences in Gorilla World and gorilla positioning, no data collection occurred during keeper presentations or for 30 min after those presentations. Data collection concluded at 5:20pm, or whenever the gorillas were taken off exhibit for the day.

Scan sampling and one-zero sampling (Altmann, 1974) were used in 20-minute intervals. Each interval had four steps to it. Step 1 used scan sampling to record the section that each individual gorilla was positioned in the gorilla enclosure at that time along with the identities of each gorilla. Step 2 used one-zero sampling to scan the visitor crowd in each of the three visitor viewing areas, recording a one if a visitor was orienting his or her vision towards their respective gorilla enclosure and a zero if they were orienting their vision in any other direction. The total number of visitors in each visitor viewing area was also attained. Step 3 involved approaching visitors in the outdoor exhibit to complete the visitor experience survey and is described in detail below. Step 4 was performed 5 min after visitor scanning in Step 2 was concluded and was a second scan sample of the gorillas' positioning inside the gorilla enclosure. No previous research has evaluated the best timeframe to measure positional changes in gorillas due to potential visitor effects. Five minutes was selected, in part, to allow the researcher sufficient time to distribute surveys in Step 3. Sound level was recorded continuously throughout the study, providing average and maximum sound levels every 10 seconds but only the values from the first two minutes of each scan were taken and used for analysis. (All gorilla data collection procedures were approved by the Institutional Animal Care and Use Committee.)

**Visitor Experience Survey.** During the 5 min gap between Steps 2 and 4 in the scan sampling procedures, visitors appearing to be 18 years old or above were approached as they moved from the outdoor exhibit viewing area to the indoor exhibit area to complete the visitor experience survey. Systematic random sampling was used to approach every fifth individual who appeared to be 18 years old or older. Participants were instructed to return their completed surveys in a specific location at the rear of the visitor viewing area. No attempts were made to find survey participants once Step 4 of each scanning interval was completed. (All human data collection procedures were approved by the Human Subjects Review Council.)

**Data Analysis**

**Scan Sampling and Sound Level.** For each scan of both the outdoor or indoor enclosure, individual gorillas positioned immediately adjacent to a visitor viewing area (e.g., left, center, and right) were assigned the highest proximity value (i.e., 3). Gorillas positioned two sections away from a visitor viewing area were rated with a lower score (i.e., 2), with decreasing proximity values being assigned as proximity to the visitor viewing area decreased (i.e., three and four sections away were rated as 1 and 0, respectively). If an individual gorilla was positioned on the border between sections, the mean proximity value of those sections was used. Individual proximity scores were calculated for each gorilla relative to all three visitor viewing areas (i.e., left, center, and right). For both the family and female groups, individual proximity values were summed for each scan, resulting in a group proximity value. Those proximity values were, then, converted to a percentage relative to the highest possible proximity value.

Visitor attentiveness data included the number of visitors in each respective visitor viewing area (i.e., crowd size), the proportion of total visitors in each viewing area (i.e., crowd density), and the proportion of visitors who were orienting their vision towards the exhibit (i.e., visitor focus). The visitor viewing area that had the most visitors present during each scan was used for analysis with gorilla proximity values corresponding to that viewing area, meaning that only one viewing area per scan was analyzed. Separate stepwise multiple regressions were used to identify relationships between the individual and group gorilla proximity values in Step 1 of the scan sampling procedure and visitor and environmental factors such as visitor focus, crowd size, crowd density, sound levels, and temperature.

To calculate proximity differences between Steps 1 and 4 of the scan sampling procedure, the difference in proximity score from Step 1 to Step 4 was calculated, using the same numeric scoring system for gorilla location as described above. A positive difference score occurred when the individual or group moved closer to the most popular visitor area and a negative difference score reflected a situation in which the gorillas moved further away. Separate stepwise multiple regressions were, then, utilized to determine if visitor and environmental factors could predict proximity difference scores.

**Visitor Experience Survey.** An exploratory principal component analysis with a varimax rotation was conducted on all eight survey items to identify any underlying structures. Two significant factors were identified and average responses on their respective items were calculated. Separate stepwise multiple regressions were, then, conducted to determine if any elements of the visitor's experience or their demographic information could predict their factor scores.

# CHAPTER IV

# RESULTS

## Visitor Experience Survey

Out of 98 respondents, 89 completed all items of the survey. Those completed responses of incomplete surveys were retained in analyses, resulting in degrees of freedom differences among analyses.

Exploratory principal component analysis with varimax rotation was conducted to determine what, if any, underlying structures existed for the eight survey items regarding visitor impressions of the care of the gorillas and of conservation efforts. The analysis produced two components with eigenvalues greater than 1.0, accounting for 45.6% and 23%, respectively, of the observed variance. See Table 3 for details. Three items loaded onto the first component which was entitled *Zoo Gorilla Perception* and four items loaded into a second component named *Concern for Gorilla Conservation*. One item did not load above 0.60 on either component and was eliminated from further analysis. An additional item with a kurtosis of 14.3 was also eliminated, leaving six remaining items with kurtosis values between 0.012 and 2.162 and skewness values between -0.452 and -1.263.

Separate stepwise multiple regressions were conducted to determine the ability of the predictor variables of number of gorilla behaviors witnessed, number of active behaviors witnessed, visitor age, time of day, member/nonmember status, and whether or not the visitor spoke to a volunteer or employee (i.e., *Yes* = 1; *No* = 2) to predict average scores for each of the two factors. Two significant predictor variables were identified, one for each factor. The number of active behaviors that the visitors witnessed impacted zoo gorilla perception, $R^2 = 0.115$, $R^2_{adj} = 0.106$, $F(1, 96) = 12.332$, $p < 0.005$, $\beta = 0.339$, indicating visitors had a more positive impression of gorilla care if they saw more active gorilla behaviors. Speaking with knowledgeable zoo employees about gorillas increased concern for gorilla conservation, $R^2$= 0.065, $R^2_{adj}$ = 0.054, $F(1, 90) = 6.18$, $p < 0.05$, $\beta = -0.255$.

Table 3

*Principal Components Identified in the Visitor Experience Survey. Answers to each item were given on a 6-point Likert scale from disagree (1) to agree (6).*

| | *M* | *SD* | Loading |
|---|---|---|---|
| **Factor 1: Concern for Gorilla Conservation.** Eigenvalue (Variance) = 3.193 (45.6%) | | | |
| I am going to find out more about the zoo's conservation efforts. | 4.0 | 1.3 | 0.870 |
| I am going to support the zoo's and/or other organizations' conservation efforts. | 4.6 | 1.4 | 0.813 |
| I am going to discuss gorilla conservation with my friends. | 3.9 | 1.2 | 0.774 |
| I am going to change some of my daily activities to benefit the environment. | 4.2 | 1.3 | 0.707 |
| **Factor 2: Zoo Gorilla Perception.** Eigenvalue (Variance) = 1.607 (23.0%) | | | |
| The zoo's gorillas seem happy and healthy. | 5.1 | 0.8 | 0.859 |
| I feel a closer connection to gorillas after viewing this exhibit. | 4.8 | 1.2 | 0.786 |

**Gorilla Proximity and Visitor Experience Survey Responses**

Stepwise multiple regression was used to determine if overall gorilla group and individual gorilla proximity to the visitor viewing area influenced factor scores from the survey. Gorilla proximity data were not directly comparable across gorilla groups due to differences in group number, necessitating separate stepwise regression analyses for each gorilla group. Visitors' zoo gorilla perception was influenced by the proximity of just Female

5 of the female group, $R^2 = 0.184$, $R^2_{adj} = 0.157$, $F(1, 32) = 6.979$, $p < 0.05$, $\beta = -0.429$, to the viewing area where the visitors reported spending the majority of their time. Unexpectedly, zoo gorilla perceptions were less positive when Female 5 was closer to a visitor's specific viewing area. No other gorilla group or individual gorilla proximity scores had effects on zoo gorilla perception. Concern for gorilla conservation scores were not influenced by gorilla proximity.

**Impact of Gorilla Proximity on Visitor Attentiveness**

As detailed previously, visitor attentiveness was measured by the three variables of: visitor focus (i.e., percentage of visitors orienting toward the enclosure), crowd size (i.e., number of visitors in the most populated visitor viewing area), and crowd density (i.e., percentage of total visitors in all three viewing areas that are located in the most popular viewing area). Crowd size and density were both used because the former represents the true number of visitors while the latter represents the proportion of the crowd affected regardless of total visitor numbers. Data for visitor attentiveness in the outdoor and indoor exhibits are presented in Table 4, while gorilla proximity data are presented in Table 5. Stepwise multiple regressions were used to determine if overall gorilla group and individual gorilla proximity influenced measures of visitor attentiveness. Differences in gorilla group numbers and exhibit design necessitated separate analyses for each gorilla group in the outdoor and indoor exhibits.

*Family Gorilla Group*

In the outdoor exhibit, the proximity of Juvenile 1, $R^2 = 0.191$, $R^2_{adj} = 0.163$, $F(1, 30) = 6.859$, $p < 0.05$, $\beta = 0.437$, impacted visitor focus. As Juvenile 1 positioned herself closer to the viewing area, a higher percentage of visitors oriented their attention to the gorilla enclosure. In the indoor exhibit, overall family group proximity to the viewing area increased crowd density, $R^2 = 0.124$, $R^2_{adj} = 0.102$, $F(1, 42) = 5.790$, $p < 0.05$, $\beta = 0.352$. Additionally, in the indoor exhibit, Female 1's proximity resulted in heightened visitor focus, $R^2 = 0.245$, $R^2_{adj} = 0.226$, $F(1, 42) = 13.292$, $p < 0.005$, $\beta = 0.495$, and the proximity of Juvenile 3 increased crowd size in the most popular viewing area, $R^2 = 0.098$, $R^2_{adj} = 0.076$, $F(1, 47) = 4.452$, $p < 0.05$, $\beta = 0.323$.

Table 4

*Measures of Average Visitor Noise Levels and Visitor Attentiveness to the Family Group (n=31 Outdoor; n=44 Indoor), Female Group (n=48 Outdoor), and Solo Silverback (n=33 Outdoor, n=39 Indoor).*

| | Outdoor Exhibit | | | Indoor Exhibit | | |
|---|---|---|---|---|---|---|
| Gorilla Groups | *M* | *SD* | Range | *M* | *SD* | Range |
| Family Group | | | | | | |
| Visitor Focus (%) | 65.3 | 22.4 | 0-100 | 81.5 | 13.2 | 31-100 |
| Crowd Size | 17.3 | 11.6 | 3-45 | 19.8 | 9.1 | 2-48 |
| Crowd Density (%) | 75.2 | 15.3 | 44-100 | 60.6 | 9.4 | 35-83 |
| Visitor Noise (dBA) | 68.4 | 0.9 | 67-71 | 73.4 | 2.8 | 68-80 |
| Female Group | | | | | | |
| Visitor Focus (%) | 68.7 | 18.6 | 21-100 | | | |
| Crowd Size | 14.9 | 7.1 | 2-32 | | | |
| Crowd Density (%) | 64.4 | 17.4 | 37-100 | | | |
| Visitor Noise (dBA) | 68.6 | 1.7 | 65-75 | | | |
| Solo Silverback | | | | | | |
| Visitor Focus (%) | 60.3 | 17.9 | 11-100 | 81.6 | 17.1 | 40-100 |
| Crowd Size | 16.6 | 7.2 | 1-31 | 12.5 | 6.3 | 1-28 |
| Crowd Density (%) | 72.4 | 16.4 | 44-100 | 68.8 | 14.5 | 44-100 |
| Visitor Noise (dBA) | 69.0 | 1.3 | 68-75 | 70.8 | 3.0 | 65-78 |

*Note:* Higher Values Indicate Greater Attentiveness for all Measures.

Table 5

*Gorilla Proximity to the Visitor Viewing Area for the Family Group (n=31 Outdoor; n=44 Indoor), Female Group (n=48 Outdoor), and Solo Silverback (n=33 Outdoor, n=39 Indoor).*

| | Outdoor Exhibit | | | Indoor Exhibit | | |
|---|---|---|---|---|---|---|
| Groups and Individuals | *M* | *SD* | Range | *M* | *SD* | Range |
| Family Group | 50.3 | 11.3 | 16.7-71.4 | 75.9 | 12.4 | 40.5-92.9 |
| Male 1 | 49.5 | 24.1 | 0.0-100.0 | 82.9 | 22.9 | 33.3-100.0 |
| Female 1 | 32.3 | 15.8 | 0.0-66.7 | 93.8 | 19.4 | 0.0-100.0 |
| Female 2 | 34.9 | 20.0 | 0.0-100.0 | 68.2 | 10.7 | 33.3-100.0 |
| Female 3 | 60.2 | 18.8 | 33.3-100.0 | 73.3 | 18.4 | 33.3-83.3 |
| Juvenile 1 | 54.8 | 22.1 | 33.3-100.0 | 82.9 | 22.0 | 0.0-100.0 |
| Juvenile 2 | 62.9 | 23.8 | 0.0-100.0 | 60.1 | 35.1 | 0.0-100.0 |
| Juvenile 3 | 57.5 | 22.3 | 0.0-100.0 | 72.5 | 31.5 | 0.0-100.0 |
| Female Group | 63.5 | 18.8 | 33.3-91.7 | | | |
| Female 4 | 51.4 | 33.3 | 0.0-100.0 | | | |
| Female 5 | 75.7 | 20.7 | 33.3-100.0 | | | |
| Solo Silverback - Male 2 | 56.1 | 17.3 | 33.3-100.0 | 90.2 | 16.3 | 33.3-100.0 |

*Note:* Higher Values Indicate Positioning Closer to the Visitor Viewing Area. The proximity data presented here represent the percentage of the highest possible proximity value given.

*Female Gorilla Group*

In the outdoor exhibit, the overall female gorilla group's proximity to the most popular viewing area increased both crowd size, $R^2 = 0.105$, $R^2_{adj} = 0.085$, $F(1, 42) = 5.370$, $p < 0.05$, $\beta = 0.313$, and density, $R^2 = 0.160$, $R^2_{adj} = 0.142$, $F(1, 47) = 8.747$, $p < 0.01$, $\beta = 0.400$. Individually, Female 4's proximity increased visitor focus, $R^2 = 0.121$, $R^2_{adj} = 0.101$, $F(1, 42) = 6.307$, $p < 0.05$, $\beta = 0.495$. No data were collected for the female gorilla group in the indoor enclosure.

*Solo Silverback*

The solo silverback's proximity did not affect visitor attentiveness in the outdoor exhibit aside from a marginal trend of increasing visitor focus, $R^2 = 0.093$, $R^2_{adj} = 0.064$, $F(1, 32) = 3.193$, $p = 0.084$, β = 0.306. In the indoor exhibit, the solo silverback's proximity increased crowd density, $R^2 = 0.132$, $R^2_{adj} = 0.109$, $F(1, 38) = 5.637$, $p < 0.05$, β = 0.364.

**Visitor Attentiveness, Environmental Factors, and Changes in Gorilla Proximity**

Lastly, stepwise multiple regressions were used to determine if crowd size, crowd density, visitor focus, temperature, and noise level in the visitor viewing area would predict changes in the gorillas' proximity to the viewing area. For the family gorilla group in the outdoor exhibit, as crowd size increased, $R^2 = 0.199$, $R^2_{adj} = 0.171$, $F(1, 30) = 7.196$, $p < 0.05$, β = -0.446, the group distanced itself from the visitor viewing area. Additionally, as both crowd size and the temperature increased, $R^2 = 0.413$, $R^2_{adj} = 0.371$, $F(2, 30) = 9.839$, $p < 0.005$, β = -0.640 (crowd size), β = -0.508 (temperature), Male 1 moved away from the visitor viewing area. Neither the female gorilla group nor the solo silverback showed changes in proximity due to visitor attentiveness or environmental factors. Difference in proximity scores between scans in the outdoor and indoor enclosures can be found in Table 6.

Table 6

*Difference Scores between Scan Steps 1 and 4 for Gorilla Proximity to the Visitor Viewing Area for the Family Group (n=31 Outdoor; n=44 Indoor), Female Group (n=48 Outdoor), and Solo Silverback (n=33 Outdoor, n=39 Indoor).*

| | Outdoor Exhibit | | | Indoor Exhibit | | |
|---|---|---|---|---|---|---|
| Groups and Individuals | *M* | *SD* | Range | *M* | *SD* | Range |
| Family Group | -0.03 | 0.2 | -0.4-0.4 | 0.05 | 0.3 | -0.5-1.0 |
| Male 1 | -0.29 | 0.7 | -2.0-1.0 | 0.18 | 0.6 | -1.0-2.0 |
| Female 1 | 0.03 | 0.2 | 0.0-1.0 | 0.03 | 0.4 | -1.5-2.0 |
| Female 2 | 0.02 | 0.1 | 0.0-0.5 | -0.05 | 0.3 | -1.0-1.0 |
| Female 3 | 0.13 | 0.4 | -1.0-1.0 | 0.07 | 0.3 | 0.0-2.0 |
| Juvenile 1 | -0.03 | 0.7 | -1.5-2.0 | 0.07 | 0.5 | -1.0-2.0 |
| Juvenile 2 | -0.05 | 0.4 | -1.5-0.5 | -0.07 | 0.8 | -3.0-2.0 |
| Juvenile 3 | -0.03 | 0.4 | -1.0-1.0 | 0.07 | 0.6 | -2.5-1.0 |
| Female Group | -0.05 | 0.2 | -1-0.1 | | | |
| Female 4 | -0.13 | 0.5 | -1.5-1.0 | | | |
| Female 5 | -0.09 | 0.6 | -2.0-1.0 | | | |
| Solo Silverback - Male 2 | -0.23 | 0.7 | -2.5-1.0 | -0.23 | 0.7 | -2.5-1.0 |

*Note*: Negative Values Indicate Positioning further from the Visitor Viewing Area. The Maximum Change Possible in Either Direction was +/- 3. Group Values were Reported as the Average of all Individuals in that Group.

# CHAPTER V

# DISCUSSION

The current findings demonstrate that gorilla behavior impacts zoo visitors' experiences and perceptions in specific ways and that visitor attentiveness can exert effects on gorilla positioning within their enclosures. In particular, visitor perceptions of the zoo's gorillas were improved both by witnessing more active gorilla behaviors and the proximity of Female 4 of the female group to the visitor viewing area. Visitor perceptions of gorilla conservation efforts were improved if they spoke with a volunteer or employee about gorillas. With regard to measures of visitor attentiveness, proximity of the gorilla groups, as well as individual gorillas to the visitor viewing area increased measures of visitor attentiveness in both the outdoor and indoor exhibits. Lastly, in evaluating potential reciprocal positioning dynamics and visitor effects on gorilla movement in their enclosure, the family group as a whole moved away from the most popular visitor viewing area as crowd size increased while Male 1 decreased proximity to the viewing area as crowd size and temperature increased.

## Zoo Visitor Perceptions

In the current study, the number of active gorilla behaviors that visitors reported seeing predicted more favorable perceptions of the zoo's care for the gorillas, whereas the number of overall behaviors visitors reported seeing did not influence those perceptions. Packer, Ballantyne, and Luebke (2018) also found that observing active behaviors improved perceptions of animal welfare in gorillas, and that visitors frequently referenced activity levels as a reason for their perceptions of the gorillas' health and happiness. A similar relationship was reported for an elephant exhibit (Miller, Luebke, & Matiasek, 2018) in which, zoo visitors were asked to identify behaviors they had witnessed. Increased animal activity levels have been found to increase visitor stay time and attentiveness in exhibits (Bitgood et al., 1988; Margulis, Hoyos, & Anderson 2003) as well as increase the frequency of animal-related topics in visitor conversations (Altman, 1998), and visitors view animal activity as one of the most desirable zoo animal traits (Carr, 2016b).

Together, these findings indicate that animal activity levels influence visitors' perceptions of overall animal well-being and their level of care while also contributing to an enjoyable and thought-provoking zoo experience. The interrelatedness of animal activity, visitor stay time and increased visitor attention make it difficult to discern which factor is directly causal in altering visitor perceptions. Despite this, zoos can design exhibits and enrichment to promote more active lifestyles in their animals, thereby improving visitors' perceptions of the health and welfare of the animals in those same enclosures. Large enclosures, the presence of moveable objects, and multiple conspecifics are all factors that may promote active behaviors in gorillas, as all have been found to impact active behaviors in orangutans (Perkins, 1992). Birke (2002) found that providing fresh browse to orangutans not only increased foraging behaviors, but it also decreased the amount of time spent sitting in the enclosure, which may also be applicable for gorillas.

Surprisingly, zoo visitors who were physically closer to Female 5 of the female group reported poorer perceptions of gorilla care at the zoo. This effect was only observed for Female 5 with no other individual animal's or group's proximity influencing zoo visitor perceptions as reported on the visitor surveys. This finding contrasts with prior research in which close encounters between a visitor and a zoo animal improved zoo visitors' views of the zoo's animals (Hacker & Miller, 2016) as well as their overall zoo experience

(Ballantyne, Packer, & Sutherland, 2011; Woods, 2002). The relationship observed here may be, in part, unique to the gorilla group studied. Female 5 was the more dominant of the two gorillas in the female group, and may have displayed aggressive behavior or displaced Female 4 which may have been viewed by visitors as behavior unbefitting of a healthy gorilla group. Additionally, the proximity of Female 4 to the visitor viewing areas increased visitor focus, which may have made these displacements even more obvious to the visitors when they happened in close proximity, contributing to decreased visitor perceptions of the animals' welfare. Such an explanation is supported by Blaney and Wells (2004) finding that when camouflage netting was installed in front of visitor viewing areas, visitors reported more favorable perceptions of gorillas as well as less aggressive gorilla behavior. Thus, zoos may want to design enclosures that limit potential aggressive behaviors adjacent to the visitor viewing areas or provide educational signage or staff members to explain that such behaviors can be part of an animal's typical behavioral repertoire.

Talking to either a volunteer or employee about gorillas improved zoo visitors' desires to support or discuss efforts involving gorilla conservation, replicating previous findings at an elephant exhibit where visitors reported that speaking with a volunteer or staff member increased their conservation intent (Hacker & Miller, 2016). Zoos have increasingly incorporated conservation promotion and wildlife education into their mission statements (Tribe & Booth, 2003), and raising visitor awareness should help accomplish that goal. In the current study, neither proximity of the gorillas to the visitors nor the gorillas' activity levels influenced visitors' opinions on conservation, suggesting that just experiencing an exhibit is not enough to alter further improve conservation attitudes. Interactions with zoo personnel may allow visitors to satiate their curiosity about the animals while offering employees or volunteers the opportunity to speak about important conservation issues without visitors feeling pressured or coerced. Given the relationship between staff interactions and conservation perceptions, zoos may find that increasing volunteer or employee presence at exhibits could be a particularly effective method of improving visitors' views toward conservation.

**Gorilla Proximity and Visitor Attentiveness**

As was expected, gorilla proximity to the visitor viewing area increased visitor attentiveness. Whereas group proximities in the outdoor exhibit affected crowd size and crowd density, individual gorillas only influenced visitor focus, suggesting that group proximity played a stronger role in visitor positioning within the outdoor exhibit than did the proximity of individual gorillas. Such positioning effects may have been due, in part, to differences in exhibit design. The front of the outdoor enclosure was further away from the viewing area than was the indoor enclosure, with a moat providing approximately 4.5 meters of separation in the outdoor exhibit while only a glass window several inches thick separated the gorilla enclosure from the visitor viewing area in the indoor exhibit. Thus, visitors to the outdoor exhibit had an increased field of vision to observe the gorillas, reducing their need to reposition themselves. As well, visitors in the outdoor exhibit may not have been able to distinguish individual features of each gorilla and, therefore, shifted their attention to the entire group. In the indoor exhibit, the proximity of individual gorillas altered crowd size, crowd density, and visitor focus, suggesting that exhibit design can influence the ability of gorilla proximity to impact visitor attentiveness.

While zoos might expect that visitors would be more fascinated by a closer experience with gorillas, few studies have tracked zoo visitors orienting their heads toward an enclosure as a measure of attention. The current findings demonstrating that gorilla proximity influences visitor attentiveness correspond to prior studies showing that an animal's visibility in its enclosure impacts visitor viewing time (Bitgood et al., 1988) and enjoyment of an exhibit (Carr, 2016a), and emphasize the importance of animal behavior on zoo visitors' experiences. Also consistent with my findings, previous research has found that the proximity of an animal to a viewing area affects the likelihood of a visitor to stop at an exhibit (Bitgood et al., 1988), which would increase crowd size, density, and visitor focus.

Collectively, the findings of this study indicate visitors are affected by individual gorillas as well as entire gorilla groups. Visitors' focus, crowd size, and crowd density in the viewing area were increased when gorillas were in close proximity to the visitor viewing areas. Given these findings, zoos might consider designing exhibits that promote closer experiences for visitors. A study investigating space use of gorillas in a naturalistic exhibit (Ross, Schapiro, Hau, & Lukas, 2009) found that gorillas most frequently utilized spaces directly next to permanent, climbable elements of exhibits and glass walls, suggesting that exhibits with glass viewing windows and climbable elements closer to visitor viewing areas may result in gorillas positioning themselves closer to visitors and enhancing zoo visitors' experience.

**Visitor Attentiveness and Difference in Gorilla Proximity**

Visitor effects that increase stress behaviors such as self-scratching, aggression, and visual monitoring have been found at individual (Stoinski, Jaicks, & Drayton, 2011; Quadros et al., 2014) and group levels in gorillas (Kuhar, 2008; Carder & Semple, 2008; Wells, 2005; Blaney & Wells, 2004). The current study observed visitor effects on animal movement at both the group and individual level with the entire family group and Male 1 of the family group distancing themselves from the most popular outdoor visitor area as the number of visitors increased. Siamangs and white-cheeked gibbons similarly responded to days of higher attendance by positioning themselves in areas that were less visible and further from the crowds (Smith & Kuhar, 2010), and Kuhar (2008) found that gorillas moved into less visible positions in the presence of larger crowds. That individual visitor effects were observed in Male 1 in the present study may be due to a silverback's role as protector of his group (Watts, 1996). Baldellou and Henzi (1992) found that male vervet monkeys spent more time than females being vigilant, particularly during breeding season, suggesting that the primary reason for vigilance is to protect the females of the troop. Similar reasoning may explain why Male 1 in the family group but not the solo silverback demonstrated position changes in response to visitor attentiveness.

Increasing temperature also contributed to Male 1 of the family group shifting positions away from the visitor viewing area in the outdoor exhibit. This study occurred during the summer and the rear of the outdoor enclosure had a large, rocky wall that provided shade, perhaps explaining our finding.

Surprisingly, noise levels in the outdoor visitor viewing area did not impact group or individual gorilla positioning; a finding consistent with Quadros et al. (2014) who also found that noise levels did not alter individual gorilla movement in a zoo enclosure. However, that same study did find that noise levels affected individual gorilla vigilance and vigilance in orangutans was also found to be influenced by visitor noise (Birke, 2002). Differences in findings across studies may be, in part, due to exhibit design. In the current study, the outdoor exhibit incorporated waterfall elements that could have provided a background ambient noise that minimized visitor noise effects. And, of course, indoor enclosures are temperature-controlled with thick glass windows reducing noise entering the enclosure, making visitor noise less likely to alter gorilla behavior.

The current study demonstrated visitor effects on the positioning of gorillas in their enclosure, and previous research has also identified visitor effects on gorilla stress behaviors at either group or individual levels (Stoinski et al., 2011; Quadros et al., 2014; Kuhar, 2008; Carder & Semple, 2008). Unfortunately, such effects appear inconsistently, varying across group composition, enclosure type, and species, and indicating that more research would be useful to clarify variability across studies. Despite differences in findings across studies, zoos can still take actions to mitigate potential visitor effects such as camouflage netting in front of visitor viewing areas which not only decreased gorilla stress behaviors but also improved visitors' opinions of the gorillas (Blaney & Wells, 2004). Food enrichment and forage could also be scattered near viewing areas to enhance visitors' experiences by increasing proximity in a context (i.e., presence of food enrichment) that has been shown to decrease visitor effects on stress behaviors in gorillas (Carder & Semple, 2008).

To our knowledge, this is the first study to demonstrate that the proximity of individual animals, in addition to gorilla groups as a whole, can directly impact zoo visitor behavior. The current findings also indicate that visitor attentiveness can affect gorilla movement within their enclosure at a group and individual level, augmenting previous research which found that crowd size altered the behavior of individual gorillas (Stoinski et al., 2011). We propose that our data support the presence of a behavioral feedback loop between visitor and gorilla which may complicate assessment of visitor effects and contribute to inconsistencies across studies. As gorillas position themselves closer to an exhibit viewing area, visitors become more attentive and larger crowds form. Then, for some animals or groups, the increase in visitor attentiveness may lead to the gorillas positioning themselves further from the viewing area, which could decrease visitor attentiveness. Decreased visitor attentiveness could, then, result in animals moving closer to the viewing area which would restart this cycle. Additional research is required to support the presence of this feedback loop, but the existence of such a visitor-animal relationship has been suggested in previous studies (Quadros et al., 2014; Margulis et al., 2003).

**Limitations**

The current findings are not without limitations. My inability to document a behavioral feedback loop outside of the family group and Male 1 may have been due, in part, to the timing of my procedures, which measured gorilla movement five minutes after measuring visitor attentiveness. This timeframe between scans may have been too long to observe direct impacts of visitor attentiveness on gorilla movement in the female group or solo silverback and may have allowed more time for outside variables to affect the gorillas. Additionally, visitor attentiveness prior to Scan 1 of gorilla proximity could have had a delayed influence on gorilla positioning. As well, my data collection was limited to days with less than 12,000 visitors at the zoo, and the presence of a behavioral feedback loop may be more apparent when visitor numbers are higher. Another potential limitation was that the sound level meter was positioned in the center visitor viewing area and not in the gorilla enclosures, which means that the sound levels that the gorillas experienced were not identical to the levels recorded.

Two of the three gorilla groups in the current study were atypical for zoo-housed gorillas. The female group and solo silverback were being prepared for introduction to each other during the course of the study, providing a unique opportunity to assess visitor-gorilla interactions when a family group is not fully formed. Although many zoos have full family or bachelor groups, temporary arrangements are not uncommon, and understanding visitor-gorilla relationships in such contexts is still valuable. As well, although I found that visitors' zoo gorilla perceptions and concern for gorilla conservation could be influenced by specific elements of their zoo visit, I do not know if these perceptions are retained long-term.

**Conclusion**

In summary, the current study outlines how the experience within a gorilla exhibit can affect both visitors' behaviors and perceptions. It also shows that changes in visitor attentiveness can influence gorilla behavior at a group or individual level. Promoting close proximity and active species-typical behaviors in gorillas, along with providing opportunities for zoo staff to talk with visitors, can contribute to improving visitors' perceptions of the animals as well as conservation efforts for those animals. Lastly, my data provide evidence for the presence of a behavioral feedback loop in which the gorillas and visitors react to changes in each other's behaviors. I hope that continued research will help elucidate the mechanisms and strength of that interaction as well as provide information that can be used to design exhibits and viewing areas that maximize zoo visitors' experiences while minimizing potential negative visitor effects on the animals.

REFERENCES


Altman, J. (1998). Animal activity and visitor learning at the zoo. *Anthrozoös, 11*(1), 12-21.

Altmann, J. (1974). Observational study of behavior: Sampling methods. *Behaviour*, *49*(3), 227–266.

Association of Zoos and Aquariums (2014). *Species Survival Plan® (SSP) Program Handbook.* Association of Zoos and Aquariums, Silver Spring, MD.

Association of Zoos and Aquariums. (2017, October). Zoo and aquarium statistics. Retrieved from https://www.aza.org/zoo-and-aquarium-statistics

Association of Zoos and Aquariums. (2018). About us. Retrieved from https://www.aza.org/about-us

Association of Zoos and Aquariums. (2019). *The accreditation standards & related policies*. Association of Zoos and Aquariums, Silver Springs, MD.

AZA Ape TAG. (2010). *Chimpanzee (Pan troglodytes) care manual*. Association of Zoos and Aquariums, Silver Spring, MD.

AZA Gorilla Species Survival Plan. (2017). *Gorilla care manual*. Silver Spring, MD: Association of Zoos and Aquariums.

AZA Jaguar Species Survival Plan (2016). Jaguar Care Manual. Silver Spring, MD: Association of Zoos and Aquariums.

Baldellou, M., & Henzi, S. P. (1992). Vigilance, predator detection and the presence of supernumerary males in vervet monkey troops. *Animal Behaviour, 43*(3), 451-461.

Ballantyne, R., Packer, J., & Sutherland, L. (2011). Visitors' memories of wildlife tourism: Implications for the design of powerful interpretive experiences. *Tourism Management, 32*(4), 770-779.

Birke, L. (2002). Effects of browse, human visitors and noise on the behavior of captive orangutans. *Animal Welfare*, *11*, 189–202.

Bitgood, S., Patterson, D., & Benefield, A. (1988). Exhibit Design and Visitor Behavior. *Environment and Behavior*, *20*(4), 474–491.

Blaney, E. C., & Wells, D. L. (2004) The influence of a camouflage net barrier on the behavior, welfare and public perceptions of zoo-housed gorillas. *Animal Welfare*, *13*(2), 111-118

Bloomfield, R. C., Gillespie, G. R., Kerswell, K. J., Butler, K. L., & Hemsworth, P. H. (2015). Effect of partial covering of the visitor viewing area window on positioning and orientation of zoo orangutans: A preference test. *Zoo Biology*, *34*(3), 223–229.

Bonnie, K. E., Ang, M. Y. L., & Ross, S. R. (2016). Effects of crowd size on exhibit use by and behavior of chimpanzees (*Pan troglodytes*) and Western lowland gorillas (*Gorilla gorilla*) at a zoo. *Applied Animal Behaviour Science*, *178*, 102–110.

Carder, G., & Semple, S. (2008). Visitor effects on anxiety in two captive groups of western lowland gorillas. *Applied Animal Behaviour Science*, *115*(3–4), 211–220.

Carr, N. (2016a). An analysis of zoo visitors' favourite and least favourite animals. *Tourism Management Perspectives*, *20*, 70–76.

Carr, N. (2016b). Ideal animals and animal traits for zoos: General public perspectives. *Tourism Management, 57*, 37-44.

Chamove, A. S., Hosey, G. R., & Schaetzel, P. (1988). Visitors excite primates in zoos. *Zoo Biology*, *7*(4), 359–369.

Chen, F. C. & Li, W. H. (2001). Genomic divergences between humans and other hominoids and the effective population size of the common ancestor of humans and chimpanzees. *The American Journal of Human Genetics, 68*(2), 444-456.

Cincinnati Zoo and Botanical Garden. (2018). History, mission and vision. Retrieved from http://cincinnatizoo.org/about-us/history-and-vision/

Cooke, C. M., & Schillaci, M. A. (2007). Behavioral responses to the zoo environment by white handed gibbons. *Applied Animal Behaviour Science*, *106*(1–3), 125–133.

The Gorilla Foundation. (2017). Status of gorillas worldwide. Retrieved from http://www.koko.org/status-gorillas-worldwide.

Gorillas Land. (2017). Current North American captive gorilla population. Retrieved from https://gorillasland.yolasite.com/north-american-database.php

Hacker, C. E., & Miller, L. J. (2016). Zoo visitor perceptions, attitudes, and conservation intent after viewing African elephants at the San Diego Zoo Safari Park. *Zoo Biology*, *35*(4), 355–361.

Hosey, G., Melfi, V., Formella, I., Ward, S. J., Tokarski, M., Brunger, D., … Hill, S. P. (2016). Is wounding aggression in zoo-housed chimpanzees and ring-tailed lemurs related to zoo visitor numbers? *Zoo Biology*, *35*(3), 205–209.

Kuhar, C. W. (2008). Group differences in captive gorillas' reaction to large crowds. *Applied Animal Behaviour Science*, *110*(3–4), 377–385.

Lindemann-Matthies, P., & Kamer, T. (2005). The influence of an interactive educational approach on visitors' learning in a Swiss zoo. *Science Education, 90*(2), 296-315.

Luebke, J. F., & Matiasek, J. (2013). An exploratory study of zoo visitors' exhibit experiences and reactions. *Zoo Biology*, *32*(4), 407–416.

Luebke, J. F., Watters, J. V., Packer, J., Miller, L. J., & Powell, D. M. (2016). Zoo visitors' affective responses to observing animal behaviors. *Visitor Studies*, *19*(1), 60–76.

Lukas, K. E., & Ross, S. R. (2005). Zoo visitor knowledge and attitudes toward gorillas and chimpanzees. *Journal of Environmental Education*, *36*(4), 33–49.

Margulis, S., Hoyos, C., & Anderson, M. (2003). Effect of felid activity on zoo visitor interest. *Zoo Biology, 22*(6), 587-599.

McCarthy, D. P., Donald, P. F., Scharlemann, J. P., Buchanan, G. M., Balmford, A., Green, J. M. H.,… Butchart, S. H. M. (2012). Financial costs of meeting global biodiversity targets: Current spending and unmet needs. *Science*, *338*(6109), 942–946.

Miller, L. J. (2012). Visitor reaction to pacing behavior: Influence on the perception of animal care and interest in supporting zoological institutions. *Zoo Biology*, *31*(2), 242–248.

Miller, L., Luebke, J., & Matiasek, J. (2018). Viewing African and Asian elephants at accredited zoological institutions: Conservation intent and perceptions of animal welfare. *Zoo Biology, 37*(6), 466-477.

Myers, O. E., Saunders, C. D., & Birjulin, A. A. (2004). Emotional dimensions of watching zoo animals: An experience sampling study building on insights from psychology. *Curator: The Museum Journal*, *47*(3), 299–321.

National Institute for Occupational Safety and Health. (1998). NIOSH Criteria for a Recommended Standard: Occupational Noise Exposure, Revised Criteria 1998. Cincinnati, OH.

Nimon, A. J., & Dalziel, F. R. (1992). Cross-species interaction and communication: A study method applied to captive siamang (*Hylobates syndactylus*) and long-billed corella

(*Cacatua tenuirostris*) contacts with humans. *Applied Animal Behaviour Science*, *33*(2), 261-272.

Owen, C. (2004). Do visitors affect the Asian short-clawed otter in a captive environment. In *Proceedings of the 6th Annual Symposium on Zoo Research-BIAZA* (pp. 202-211).

Owen, M. A., Swaisgood, R. R., Czekala, N. M., Steinman, K., & Lindburg, D. G. (2004). Monitoring stress in captive giant pandas (*Ailuropoda melanoleuca*): Behavioral and hormonal responses to ambient noise. *Zoo Biology*, *23*(2), 147–164.

Packer, J., Ballantyne, R., & Luebke, J. (2018). Exploring the factors that influence zoo visitors' perceptions of the well-being of gorillas: implications for zoo exhibit interpretation. *Visitor Studies, 21*(1), 57-78.

Perkins, H. E. (2010). Measuring love and care for nature. *Journal of Environmental Psychology*, *30*(4), 455–463.

Perkins, L. (1992). Variables that influence the activity of captive orangutans. *Zoo Biology, 11*(3), 177-186.

Quadros, S., Goulart, V. D. L., Passos, L., Vecci, M. A. M., & Young, R. J. (2014). Zoo visitor effect on mammal behaviour: Does noise matter? *Applied Animal Behaviour Science*, *156*, 78–84.

Reade, L. S., & Waran, N. K. (1996). The modern zoo: How do people perceive zoo animals? *Applied Animal Behaviour Science*, *47*(1), 109–118.

Ross, S. R., Schapiro, S. J., Hau, J., & Lukas, K. E. (2009). Space use as an indicator of enclosure appropriateness: A novel measure of captive animal welfare. *Applied Animal Behaviour Science, 121*(1), 42-50.

Ross, S. R., Calcutt, S., Schapiro, S. J., & Hau, J. (2011). Space use selectivity by chimpanzees and gorillas in an indoor-outdoor enclosure. *American Journal of Primatology*, *73*(2), 197–208.

San Diego Zoo. (2018). San Diego Zoo global mission and vision. Retrieved from http://zoo.sandiegozoo.org/content/san-diego-zoo-global-mission-and-vision

Scott, K., Heistermann, M., Cant, M. A., & Vitikainen, E. I. K. (2017). Group size and visitor numbers predict faecal glucocorticoid concentrations in zoo meerkats. *Royal Society Open Science*, *4*, 161017.

Sellinger, R. L., & Ha, J. C. (2005). The effects of visitor density and intensity on the behavior of two captive jaguars (*Panthera onca*). *Journal of Applied Animal Welfare Science*, *8*(4), 233–244.

Smith, K. N., & Kuhar, C. W. (2010). Siamangs (*Hylobates syndactylus*) and white-cheeked gibbons (*Hylobates leucogenys*) show few behavioral differences related to zoo attendance. *Journal of Applied Animal Welfare Science*, *13*(2), 154–163.

Stevens, J. M. G., Thyssen, A., Laevens, H., & Vervaecke, H. (2013). The influence of zoo visitor numbers on the behaviour of harbour seals (*Phoca vitulina*). *Journal of Zoo and Aquarium Research*, *1*(1), 31–34.

Stoinski, T. S., Jaicks, H. F., & Drayton, L. A. (2012). Visitor effects on the behavior of captive western lowland gorillas: The importance of individual differences in examining welfare. *Zoo Biology*, *31*(5), 586–599.

Sulser, C. E., Steck, B. L., & Baur, B. (2008). Effects of construction noise on behaviour of and exhibit use by snow leopards (*Uncia uncia*) at Basel Zoo. *International Zoo Yearbook*, *42*(1), 199–205.

Tribe, A., & Booth, R. (2003). Assessing the role of zoos in wildlife conservation. *Human Dimensions of Wildlife, 8*(1), 65-74.

United States Congress. 1966; amended 1970, 1976, 1985, and 1990. Animal Welfare Act. 7 U.S.C. 2131-2156.

Watts, D. P. (1996). Comparative socio-ecology of gorillas. *Great ape societies*. (pp 16-28). Cambridge; New York, NY, USA: Cambridge University Press.

Wells, D. (2005). A note on the influence of visitors on the behaviour and welfare of zoo-housed gorillas. *Applied Animal Behaviour Science, 93*(1), 13-17.

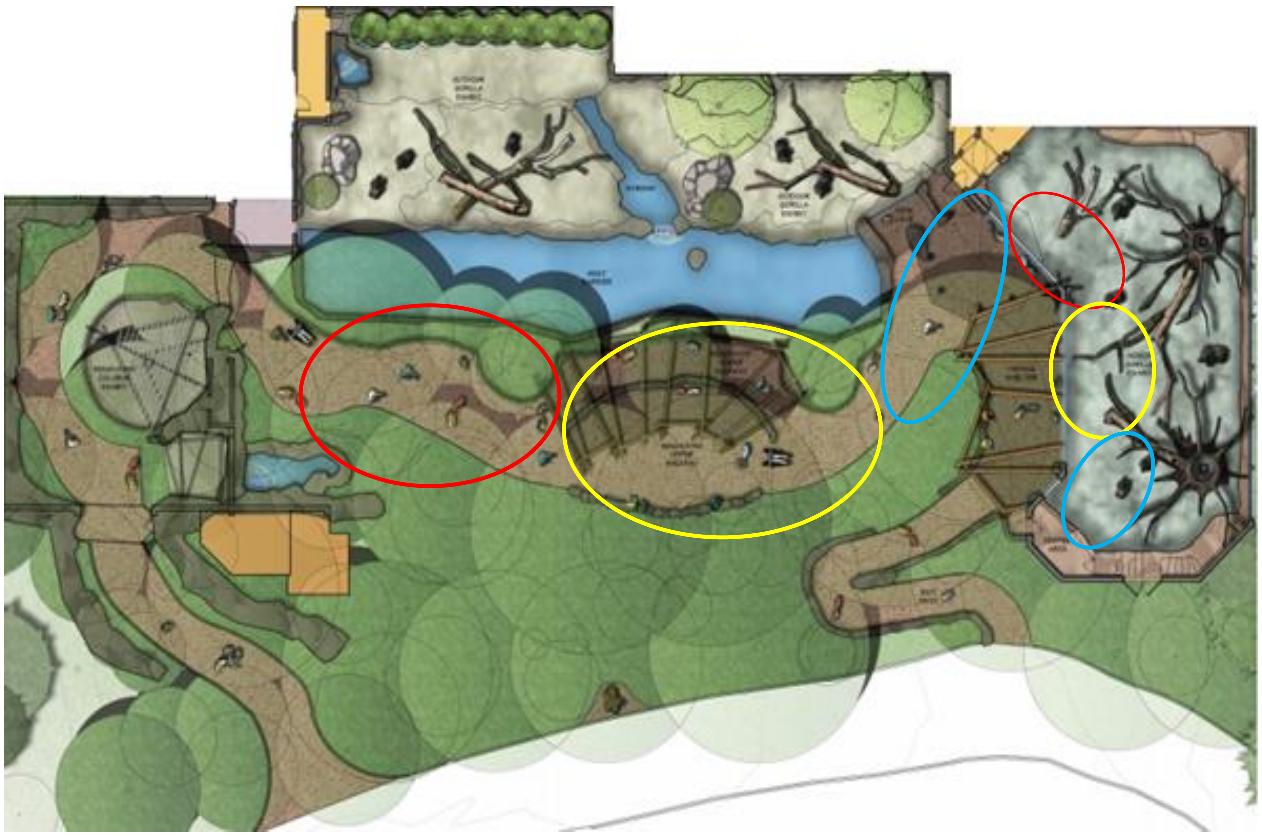
Wood, W. (1998). Interactions among environmental enrichment, viewing crowds, and zoo chimpanzees (*Pan troglodytes*). *Zoo Biology*, *17*(3), 211–230.

Woods, B. (2002). Good zoo/bad zoo: Visitor experiences in captive settings. *Anthrozoos*, *15*(4), 343–360.

APPENDIX A

**Gorilla Exhibit and Visitor Viewing Area**

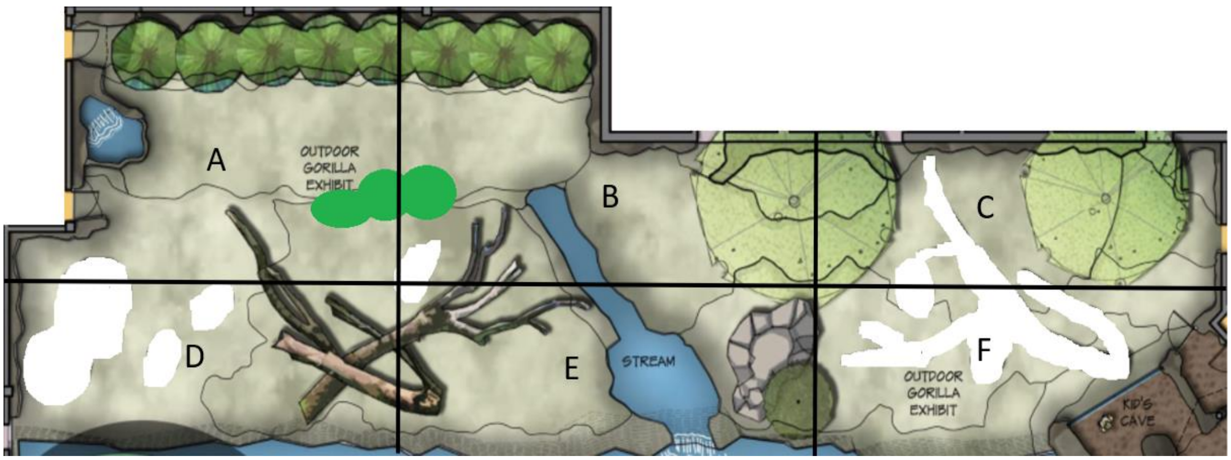
Diagram of the outdoor (left) and indoor (right) gorilla exhibits at CZBG and the corresponding visitor viewing areas. The left visitor viewing areas in each exhibit are outlined in red, the center viewing areas are outlined in yellow, and the right viewing areas are outlined in blue. Diagram provided by CZBG.



APPENDIX B

**Outdoor Enclosure Sectioning for Gorilla Proximity Scans**

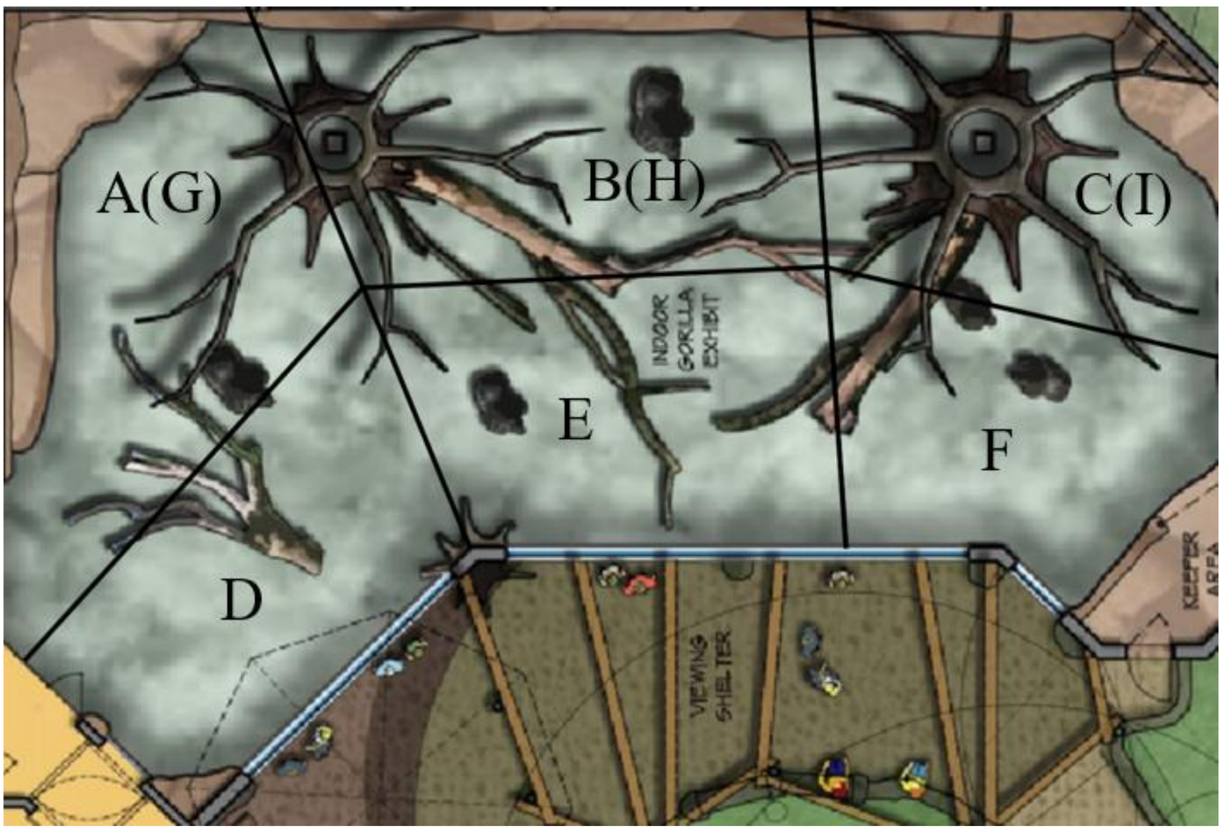
Diagram of the indoor gorilla enclosure and the sections used for proximity scanning. Each section was given a letter designation, allowing for quick and simple recording of gorilla positioning information.



## APPENDIX C

**Indoor Enclosure Sectioning for Gorilla Proximity Scans**

Diagram of the indoor gorilla enclosure and the sections used for proximity scanning. Each section was given a letter designation, allowing for quick and simple recording of gorilla positioning information. Section letters in parentheses indicate vertical sections on top of another, meaning that section G is directly above A, section H is above B, and section I is above C.



APPENDIX D

## Visitor Experience Survey

Date: _________ Time: _________

Thank you for helping with this brief exhibit survey. Your honest feedback to the questions on this survey regarding your visit to Gorilla World today will help us to create the best possible visitor and animal experience. Please be aware that responses are confidential.
If you have questions about the survey please contact, alan.bergman@cwu.edu

1) Please indicate which of the following behaviors you personally observed from any gorilla in the exhibit (check all that apply).

- ☐ Walking
- ☐ Running
- ☐ Playing
- ☐ Eating
- ☐ Drinking
- ☐ Sleeping
- ☐ Climbing
- ☐ Beating Chest
- ☐ Sitting
- ☐ Vocalizing
- ☐ Dragging Object
- ☐ Manipulating Object
- ☐ Looking Around
- ☐ Other______

2) Please indicate the degree to which you agree with the following statements about gorillas and zoos:

| | Strongly Disagree | Disagree | Slightly Disagree | Slightly Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| The zoo's gorillas seem happy and healthy. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| The zoo's gorillas seem well cared for. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I feel a closer connection to gorillas after viewing this exhibit. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am concerned about gorillas' conservation status in the wild. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

3) In response to your experience observing the gorilla exhibit, how much do you agree with the following statements?

| | Strongly Disagree | Disagree | Slightly Disagree | Slightly Agree | Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| I am going to discuss gorilla conservation with my friends. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am going to change some of my daily activities to benefit the environment. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am going to find out more about the zoo's conservation efforts. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| I am going to support the zoo's and/or other organizations' conservation efforts. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

1) Which of the following actions would you be most likely to take to support gorilla conservation? (Please choose one)
    - ☐ Donate my money
    - ☐ Volunteer my time
    - ☐ Make lifestyle changes to benefit the environment

2) When you were watching the gorillas, were you in the left, center, or right section of the viewing area (when facing the exhibit)? Please choose the area you spent the most time in.
    - ☐ Left
    - ☐ Center
    - ☐ Right
3) Personal information
    Age: ________
    With which gender do you identify? _________
    Are you a member of the Cincinnati Zoo (Circle one)? (Yes)(No)
    Did you speak to staff member or volunteer about gorillas today (Circle one)? (Yes)(No)