
**The Welfare of Wildlife in Captivity: Gorillas Enclosure Hygiene in Limbe
Zoological Garden, Southwest Region, Cameroon**

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ABSTRACT: *Captive management of wildlife species is important in the tropics, where their population is alarmingly reducing due to poaching and habitat loss. Achieving this goal needs hygiene priority to the animal enclosures in the zoos, for animals and humans health safety reasons. However, zoo management standards need to be based more on zoo-wildlife-enclosure hygiene. Hence, the main objective of this study was to examine some areas of gorilla enclosures in Limbe zoological garden, commonly called Limbe Wildlife Center. After a brief feasibility study was done, research data collection program was launched and executed for a period of four months, each day from 8: am-5: pm. Results have shown that hygiene of the zoo enclosures is significant $X^2 = 30.459$ $df=6$ $P=0.000$, $X^2 = 9.642$ $df=9$ $P<0.05$, $X^2 = 6.827$ $df=6$ $P<0.05$, and $X^2 = 4.964$ $df=3$ $P<0.05$ on enclosure floor types, gorilla position in enclosures, physical appearance of gorillas, reaction of gorillas during tourist influx respectively. Environmental hygiene is the source of good health and health safety, therefore, there is need for it to be given preventive attention. More so, the study has shown that gorilla enclosures in the zoo are clean 43%, while other ratings were recorded on wet enclosures 31%, dry enclosures 26%, and dirty enclosures 15% respectively. Nevertheless, a 15% rating on dirty zoo enclosures is relatively high for animal and humans to strive safely and healthily. Enclosures with different floor descriptions, concrete 39%, grass-cover 36%, and bare-ground 25% respectively were very useful to the social activities of all the gorillas. Furthermore, food type recorded a significance on hygiene of gorilla enclosures, $X^2 = 28.407$ $df=15$ $P=0.019$. Though, the zoo management is seemingly over-stretched due to the zoo-shut-down strategy adopted during the advent of covid-19, hygiene priority is still not optional. The in-service training of zoo workers is another goal to achieve conservation success in recent time due to the alarming rate of wildlife population decline in the wild. Hence, captive wildlife management and breeding have been resorted to for population increase. Collaborative management of wildlife species and their population is a conservation recommendation that would produce positive results in countries like Cameroon.*

KEYWORDS: Wildlife, Gorillas, Zoo-enclosures, Hygiene, Activities, Grass-cover

INTRODUCTION

In an ideal world, wild animals would have the freedom to live (and die) as they have for countless generations. The adaptations of animals have evolved in response to various environmental pressures and it is reasonable to assume that the best place for wild animals is in their natural habitat. However, this is not an ideal world and the activities of humans are rapidly pushing many species to the brink of extinction (Ehrlich and Ehrlich, 1981; Wilson, 1992; Conway, 1995). One of the principal aims of modern zoos is to ensure animal welfare is kept to an optimum standard, with evidence-based approaches taken towards animal husbandry and management (Ward et al, 2018). Zoos should be providing animals with the opportunity to thrive, not just survive (Melfi, 2009, Maple & Bloomsmit 2018). As different animal species have different needs, zoological facilities now pay closer attention to the individual needs of animals, providing appropriate environments and assessing requirements for individuals, including enrichment (Vaglio et al. 2021) and training (Spiezio et al. 2016, Spiezio et al. 2017). The zoo exposes animals to a unique environment full of novel stimuli (Morgan & Tromborg 2007). One frequently mentioned and well-researched, unpredictable stimulus is the zoo visitor.

Proper housing and management of animal facilities are essential to animal well-being, to the quality of research data and teaching or testing programs in which animals are used, and to the health and safety of personnel. A good management program provides the environment, housing, and care that permit animals to grow, mature, reproduce, and maintain good health; provides for their well-being; and minimizes variations that can affect research results. Specific operating practices depend on many factors that are peculiar to individual institutions and situations. Well-trained and motivated personnel can often ensure high-quality animal care, even in institutions with less than optimal physical plants or equipment. Although there are welfare concerns associated with all forms of captivity, there are meaningful differences impacting animal welfare between larger accredited zoos and sanctuaries and small, private, unaccredited ones. Small, unaccredited zoos, often referred to as “roadside zoos,” are often operated for profit and focus primarily on entertainment, rather than conservation and education. Larger facilities will try to copy the animal’s natural environment and will only have animals in enclosures for only part of the day, whereas roadside zoos will keep animals in the same cage or smaller enclosure with limited access to physical and psychological enrichment or opportunities for socializing.

Housing animals in a species-appropriate group including suitable sex ratios also encourages species-typical behaviors. For instance, polygynous species should be kept in groups with several females per male, as opposed to groups having an even sex ratio or more males than females (Forthman and Ogden, 1992). Furthermore, social animals should be housed with other members of their species. In the past, zoos kept some animals, even highly social apes, in isolation. This was the case for Willie B., the well-known Zoo Atlanta gorilla, who was wild-caught and spent 27 years living alone. Once the importance of a social life was fully understood, zoo staff created a

naturalistic habitat and, in 1988, introduced him to a group that he joined quite successfully (Forthman and Ogden, 1992). The controlled settings in which captive animals live give researchers excellent opportunities to learn more about species and how they interact with their surroundings, providing an easier time of doing so than might be encountered in the wild. Findings from zoo studies can help the study's subjects and fellow members of their species in captivity. In the long term, the results of behavioral studies can be applied to improve conservation initiatives and potentially resolve long-standing issues (Forthman and Ogden, 1992). This is the case for Golden lion tamarins (*Leontopithecus rosalia*), or GLTs. South American GLTs are endangered and have been a species of concern for several years now.

In some species, stereotypic behaviours are performed as a coping technique in sub optimal environments (McBride & Cuddeford 2001); in these instances research suggests that caution must be taken when acting to remove the behaviours as they currently benefit the animal by satisfying a motivation. Stereotypy in this case is claimed to be most successfully reduced by positively changing the animal's environment to encourage appropriate goal directed behaviour which increases the animal's natural behavioural repertoire (Shepherdson 1989; McBride and Cuddeford 2001, Mason et al. 2007). It is a primary responsibility of modern zoos and aquariums to provide optimal care for the animals in their collections. Providing optimal care includes maintaining an animal's physical health, through proper nutrition, adequate enclosures, and quality veterinary attention. However, optimal care is not achieved through physical health alone. Zoos and aquariums must also maintain the psychological health of their animals by providing species-appropriate social opportunities, naturalistic enclosures, and effective enrichment and training (Mench and Kreger, 1996; Mellen and Sevenich-MacPhee, 2001). Within the zoo environment, the intention is to optimize physical and psychological health to enhance animal welfare.

Wildlife conservation in captivity has many advantages, wildlife population increase through breeding, tourists' entertainment, education and research for re-introduction into the wild. But the zoo enclosures and cages keeping the wildlife need to be kept clean on standard hygiene recommendation for human and wildlife health safety expectation. Zoo hygiene cannot be compromised on any management procedure since it could equally source and cycle zoonotic infection, a huge health threat to human society and the world. The management authorities of Limbe Wildlife Centers understand this, hence, have laid down standard hygiene measures for tourist and researchers visiting the zoo. However, hygiene must have been compromised a little, some gorilla enclosures were recorded dirty during the study, a situation believed to have been caused by the overstretching work-program that involved a few workers to handle the daily routine services of zoo-sanitation.

MATERIALS AND METHODS

Description of the study area

Limbe municipality is located between latitude $3^{\circ}57' - 4^{\circ}27' N$ and longitude $8^{\circ}58' - 9^{\circ}24' E$ (fig.1). The Zoo is found at the center of the city, established in 1993 by Cameroon Government and the Pandrilus Foundation. The zoo location is crossed by roads, and situated near Limbe City Council (Melle et al.2017). All species harbored in this place had been donated by the local hunters or confiscated by the Government of Cameroon. Limbe Wildlife Center primarily helps to rescue these species and later reintroduce them to the natural environment in mount Cameroon national park (Melle et al.2017). The climate of Limbe area including the reintroduction site, Mount Cameroon National Park is characterized by a period of heavy rains occurring from the months of June to October, and a dry season period extending from November-May. At lower altitude, the annual rainfall ranges from $1,000 \text{ mm}^3$ at Cape Debundscha to less than $2,000 \text{ mm}^3$ in the north-east around Munyenge area. The mean annual rainfall decreases with altitude to approximately $4,000 \text{ mm}^3$ at 1000 m and less than $3,000 \text{ mm}^3$ above 2,000 m (Payton, 1993).The temperature falls with increasing elevation where mean air temperature is $26.78^{\circ}C$, with monthly values ranging from $24.98^{\circ}C$ in August, the rainiest month. Payton (1993) points out that, the humidity remains at 75 to 85% due to the influence of marine ecosystem. The zoo is enclosed with a strong wire-net fence with an estimated height of 10 m and a circumference of 400 m^2 .

Limbe Wildlife Centre in Cameroon is a highly-respected sanctuary for chimpanzees, gorillas and other primates, with an extensive local outreach and education programme. Its dedicated team currently cares for more than 140 animals that have been confiscated from the pet trade, many of which are bush-meat orphans, babies whose families have been killed for food. Limbe Wildlife Center provides a long-term solution for confiscated wildlife. Working with the local and international community, Limbe aims to secure the survival of the endangered wildlife species of Cameroon. Where possible, confiscated animals are released back into the wild but for many species such as apes, finding suitable habitat, free of threat but with room for new populations to be introduced, is challenging.

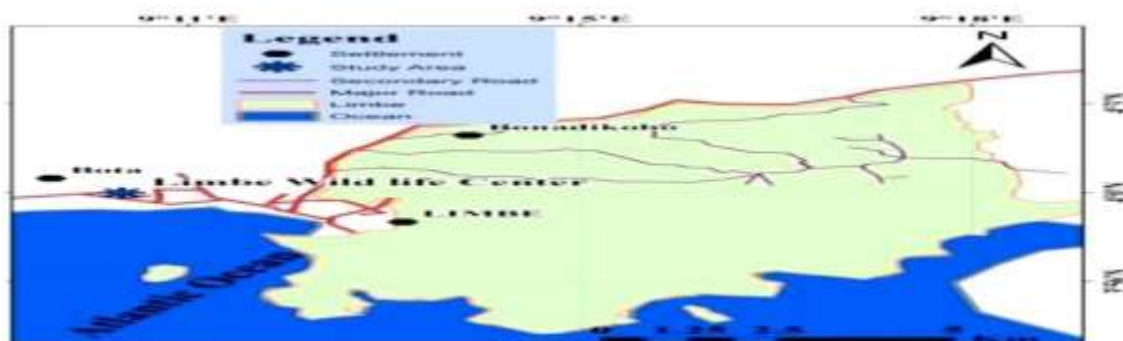


Fig. 1: Map of Limbe (Melle et al.2017)

Data collection

The research data on gorillas was collected during a period of four months, February - May, each day of the month. Preliminary non formal observation was carried out to determine the behavior categories of the subjects (Md-Zain et al., 2008b). Preliminary observation is critical for the observer to be familiar with the subjects and their behaviors, thus enabling them to choose the right measures and recording methods (Martin and Bateson, 1993). Martin and Bateson (2007) define “instantaneous scan sampling” as when “a whole group of subjects is rapidly scanned, or “censured,” at regular intervals and the behavior of each individual at that instant is recorded.” Behavioral data can be collected in several ways (Altmann, 1974). In categorizing these methods, Martin and Bateson (2007) distinguish between sampling rule (whose behavior is watched and when) and recording rules (how the behavior is recorded). Hence, data were collected on the gorilla activities in the zoo and ecological parameters during these activities.

Data analysis

Research data, entered into eco-data sheets was assembled and analyzed by using statistical tools, such as chi-square (X^2) and percentages for both inferential and exploratory analysis. The zoo enclosure hygiene was tested against enclosure floor types, the position of gorillas in enclosures (fig.3), physical appearance of gorilla, and appearance of gorillas during an influx of tourists respectively.

RESULTS

The hygiene of zoo enclosures revealed a significance $X^2 = 30.459$ $df=6$ $P=0.000$, $X^2 = 9.642$ $df=9$ $P<0.05$, $X^2 = 6.827$ $df=6$ $P<0.05$, and $X^2 = 4.964$ $df=3$ $P<0.05$ on enclosure floor types (fig.2), the position of gorillas in enclosures (fig.3), physical appearance of gorillas (fig.4), and appearance of gorillas during an influx of tourists (fig.5) respectively. Environmental hygiene is the source of good health and health safety, therefore, there is need for it to be given preventive attention. Most of the diseases, viruses, bacteria, parasites, and fungi that humans and animals are infected of are from environmental contamination. Humans and non-human primates share almost same morphological, anatomical, and physiological characteristics, and in some cases even infections. Studies have shown that most of the infection that have plaque human society, such as monkey pox, gastro-intestinal parasites, tuberculosis, meningitis, HIV etc are believed to have descended from apes and other primate species. Human health safety measures include prevention of wildlife interaction with humans in conservation units, such as zoos, game reserves, wildlife sanctuaries, and wildlife parks. Quarantine services to wild primates before translocation and re-introduction should be given priority to avoid infection spread. Reasons which any wildlife protection facility or unit such as zoos with human influx should often be given hygiene attention. This would guarantee human and wildlife safety and the objective of education, wildlife breeding, research, and entertainment would end with achievable results. Limbe Wildlife Center (LWC) harbors a good number of wildlife species, such as gorillas that would need a clean environment to enhance their dwelling and social activities. Results of this study have shown that the gorilla enclosures in the zoo are clean 43%, while other ratings were recorded wet 31%, dry 26%, and dirty 15%

respectively (fig. 6). Nevertheless, a 15% rating on dirty zoo enclosures is relatively high for animal and humans to thrive healthily safely. Wildlife welfare in captive environment like the zoo needs a healthy hygiene department with well train wildlife health personnel.

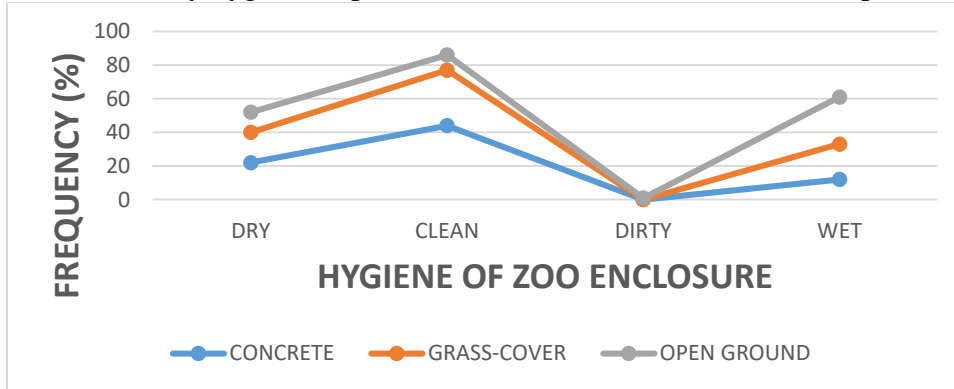


Fig. 2: Hygiene of gorilla enclosures and enclosure floor types

Enclosures with different floor descriptions, concrete 39%, grassland 36%, and bare-ground 25% respectively (fig.7) were very useful to the social activities of all the gorillas. Gorillas are herbivores, thus the grass cover enclosures also served as a source of food, though, they concentrated much on subsidized food, which was their major food source. Additionally, clean zoo enclosures provided more accommodation to gorillas while dirty enclosures provided the least. The averagely dry and wet enclosures secured some activity rating equally. However, the zoo management gave much attention to enclosure hygiene, making sure that all food particle remains were cleared every day after feeding the animals.

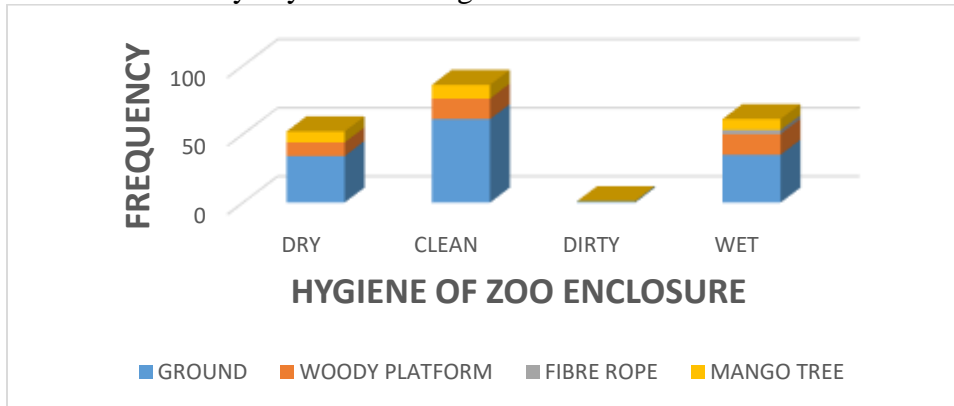


Fig. 3: Hygiene of gorilla enclosure and gorilla position in enclosure

During touristic visitation, gorillas were observed calm and actively feeding, grooming, and moving, except when they were provoked by a noisy crowd of visitors, making them swing into violent0.

fcxvc screams and roars, a sign of anger observed during intra and inter group fight in the wild and zoos. Gorillas are far more powerful than humans, hence, the least provocation was never taken lightly, rather displayed agonistic aggressive behaviors that created disturbance to other wildlife species in the zoo. Studies have shown that apes know their human feeders in captivity, however, human presence in enclosures with gorillas is not advisable, and may be dreadful and disastrous. Even with well habituated gorilla groups, the relationship should be given a reasonable distance of proximity for precaution.

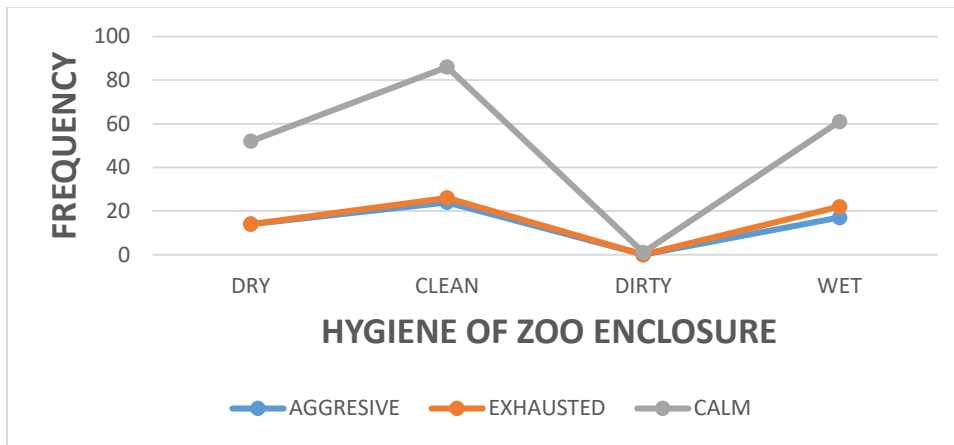


Fig.4: Hygiene of gorilla enclosure and physical appearance of gorilla

Hunger could still provoke agonistic aggressions in captive wildlife, such as lions and gorillas, but whenever fed, and then roaring or screaming behavior is still displayed, other reasons such as noisy crowd of visitors should be considered. When this situation comes up the zoo management must prevent visitors’ access to these zoo enclosures until calm is restored. Making sure zoo visitors are often cautioned to avoid noise-making at the enclosures, especially when heading to gorillas and other apes. Studies show that when captive gorillas are provoked by a crowd of noisy visitors they throw stones, sticks, and anything that could be used as a fighting weapon to them. Also, attempts to break through the wire-fence enclosure by gorillas to attack unfamiliar and provocative visitors have been reported in some zoos.

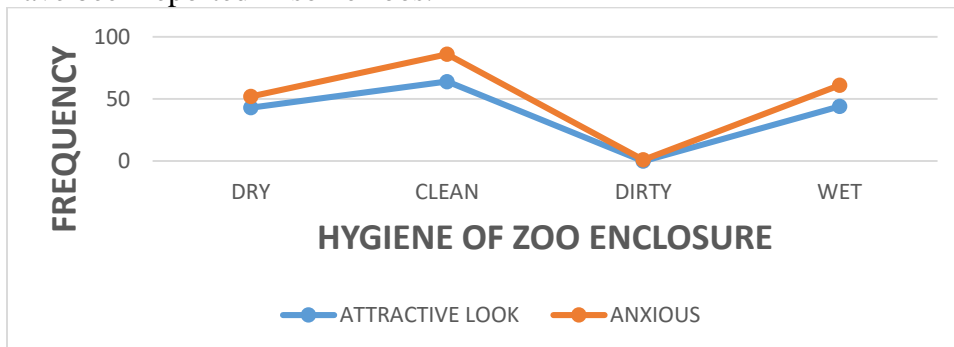


Fig.5: Hygiene of gorilla enclosure and gorilla appearance during tourists’ influx

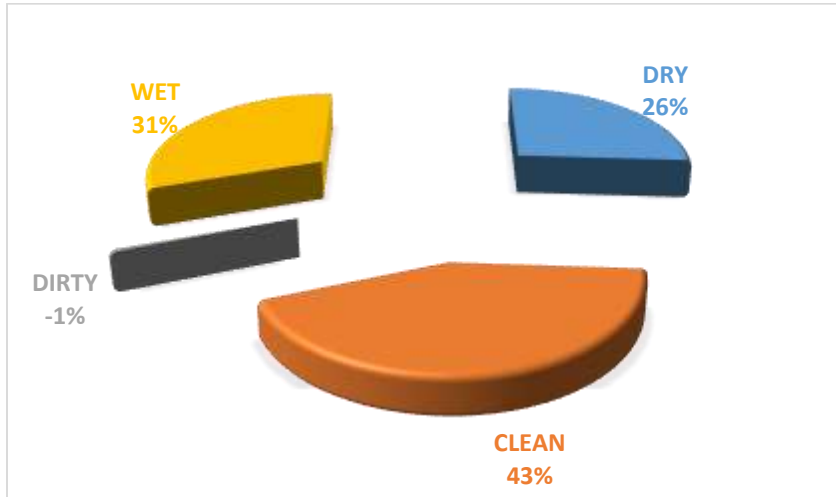


Fig. 6: Rating of the hygiene of gorilla enclosure

The silver-backed gorilla in the wild is alpha in the group, and would tolerate no other silver-backed rival in same group. In captivity, it is advisable that whenever a silver-backed gorilla emerges amongst the adult males, it automatically takes supreme control of the group, and if by peradventure any other silver-backed gorilla emerges later, it should be transferred immediately to a new enclosure to prevent dreadful episodes of leadership tussle and violence.

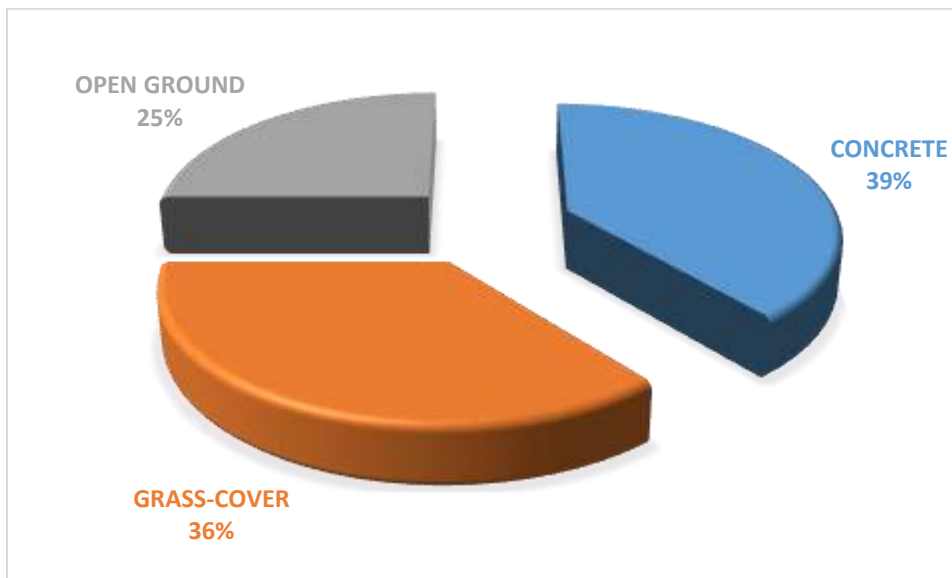


Fig. 7: Gorilla enclosure floor description

Standard zoo hygiene measures must be application in the management of zoos for human and wildlife health safety concerns, a key attraction to tourists who would not be happy perceiving

offensive odors from zoo enclosures. Visitors paying to watch wildlife in zoos prioritizes health safety measures taken by zoo management, which encourages more visits and visitors. Furthermore, management services towards tourists play a huge attractive role on zoo visitation to watch wildlife. Limbe Wildlife Center is one of the best zoos in Cameroon in access services, though, the advent of covid-19 shut down visitation for more than 1 year under the instruction of hierarchy, nevertheless, face-mask and hand-sterilization measures were introduced to visitors in revamping zoo access.

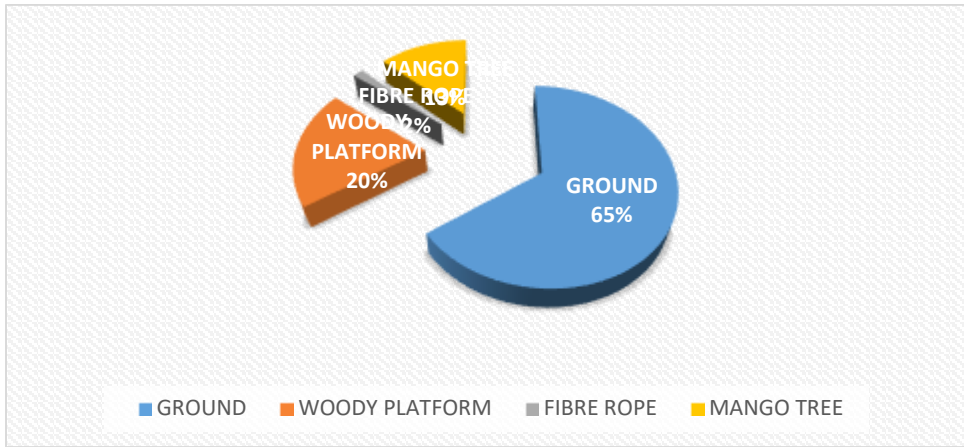


Fig.8: Gorilla position in the enclosure

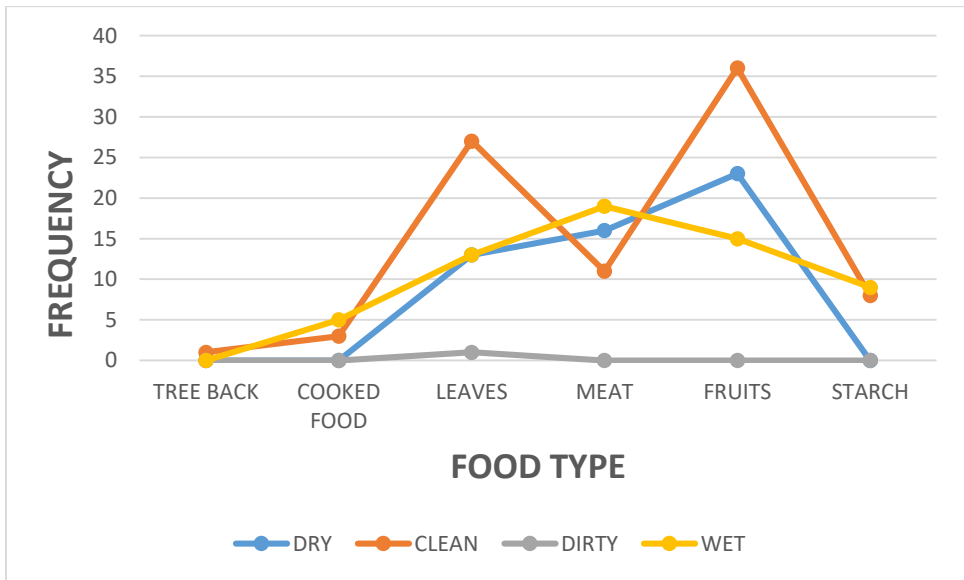


Fig.9: Food type and the hygiene of gorilla enclosure

More so, food type recorded a significance on the hygiene of gorilla enclosure, $X^2 = 28.407$ $df=15$ $P=0.019$ (fig. 9). Since the management of this zoo understands the importance of a healthy zoo environment to wildlife and visitors, they budgets much time cleaning up all the wildlife enclosures, especially before feeding them with subsidized food. The gorillas recorded a significant feeding activity on the leaves and fruits compared to other food materials. Additionally, food-material spillage and remains were the principal source of enclosure dirt.

DISCUSSION

Animal welfare has been at the forefront of many investigations, particularly in captive species such as zoo housed animals. All captive environments are required to fit the comprehensive framework for analysis of welfare as stated in the Animal Welfare Act 2006. Part of this legislation enforces the assurance of the performance of “most normal” behaviours by the provision of adequate space and resources. Monitoring behaviour to create an activity budget is a beneficial way of detecting anything abnormal in an animal’s behavioural repertoire and additionally enables the recording of their location at the time of performance to give a full account of enclosure use.

Human activity is at the heart of western lowland gorillas' endangerment and recent activity has exacerbated the species' decline (Walsh et al., 2008). The easily-spread Ebola virus has plagued wild gorillas for decades, with an observed mortality rate around 95 percent, reducing the world's gorilla populations by a third (Caillaud et al., 2006; Rizkalla et al., 2007; Robbins et al., 2004; Walsh et al., 2008). In addition, areas of Africa where gorilla populations occur are often mined and bulldozed for commercially valuable minerals and lumber, urbanization, and subsistence agriculture. Cleared land makes gorillas even more accessible to poachers, indirectly abetting the bush-meat trade, illegal export, and other profit-generating businesses (Kasereka et al., 2006; Walsh et al., 2008). The national and international regulations that protect threatened species are not well enforced, and the lack of enforcement is a major problem for wild gorillas (Gates, 1996). One strategy for protecting gorillas has been to encourage tourism based on viewing them, but the ecotourism business can be both a detriment and a boon to wild gorillas. It has been noted that wild populations are stable for extended periods of time in areas that receive a high volume of tourists. In a long-term study of Bwindi Impenetrable National Park, a tourism hot spot, gorilla groups were larger overall, had a greater number of immatures in their groups, and signs of illegal poaching were significantly reduced compared to previous years (McNeilage et al., 2001). The reason for the apparent decrease in poaching can be attributed to constantly-increasing law enforcement and public education.

Environmental enrichment programs are important in that they provide for the well-being of the animals, allow the animals to display “natural” behaviors to the public, and increase reproductive success (Sheperdson et al., 1998). Adding natural substrate, vegetation, water features, rocks, and other features not only makes the environment more pleasant for the animals, but it also increases the educational value of zoo exhibits for visitors. Poole (1998) explains that the captive

environment should be sufficiently complex to allow a full range of locomotor activities, including walking, climbing, swimming, or burrowing as appropriate to the species concerned. In the wild, a mammal chooses a living area that offers suitable facilities for its needs, so the zoo manager should do the same for those in his care. Carlstead (1998) illustrates that making the environment more complex and unpredictable can reduce stereotypic behavior; by providing stimuli, you reduce the tiger's desire to perform a negative behavior (Carlstead, 1998).

Zoological facilities care for a vast array of species, for which there may be limited longevity data, veterinary reference values, behavioral baselines, or even standardized care practices. Recognizing this, accrediting organizations are developing animal care manuals that collate as much information about a species as possible to support their care. For example, the Association of Zoos and Aquariums (AZA) now has 27 animal care manuals published and 25 currently in progress. With modern veterinary medicine and nutrition science, many animals that are cared for by humans now survive well past the average lifespan of their wild counterparts (Kohler et al.2006). Ensuring a positive quality of life during these years is a growing concern among those who care for animals (Rollin, 2007). The challenges of caring for ageing animals are manifold and information regarding age-related changes in many species living in zoos is limited. The increasing focus on ensuring positive well-being for animals in accredited zoos and aquariums across all life stages, coupled with the increase in overall longevity of the species living in zoos and aquariums highlights the current need for a clearer understanding of challenges and considerations involved in providing care and supporting positive welfare opportunities for aged animals. Zoos and aquariums are increasingly focused on animal welfare.

Early welfare work focused on eliminating animals' negative experiences (e.g., freedom from pain Britain & Brambell 1965), however in recent years animal welfare science has increasingly focused on the positive well-being of animals (Mellor & Beausoleil 2015). Moreover, modern animal welfare science acknowledges providing proper environmental provisioning for an animal is necessary but not sufficient for ensuring the positive welfare of each individual of a given species (Mellor 2016). Positive welfare is associated with numerous opportunities including the ability to exert agency in daily life (Bassett & Buchanan-Smith 2007, Krebs & Watters 2017), engagement with the environment (e.g., physical and social aspects of one's world (Swaisgood et al. 2001, Kuczaj et al.2002), problem solving (Krebs & Watters 2017, Manteuffel et al.2009, Clark 2013), and acquiring rewards Laule 2003). As welfare is a state experienced by an individual and dependent upon one's preferences, experiences, and personality, supporting positive welfare requires an understanding of characteristics that can impact welfare states.

CONCLUSION

Hygiene is an important tool in zoo management for health safety reasons, and its negligence could be a leeway to disease spread within the wildlife population in the zoo and their human neighbors. Zoonotic infections might have used wildlife conservation facilities to contaminate humans. This

is why human and wildlife quarantine measures have been introduced to the zoo access. Limbe Wildlife Center is a wildlife conservation unit, harboring many species of wildlife including guerillas seized from poachers across the region. The study also disclosed an up-to-date hygiene strategy in the gorilla enclosures, however, the aspect of negligence recorded on filthy enclosures indicates and signals a need for standard hygiene procedures. Since tourist visitation prioritizes zoo-hygiene as a key health-safety component on the entertainment, it must be taken seriously, if enough income should be expected from tourist influx. Though, the zoo management is seemingly over-stretched due to the zoo-shut-down strategy adopted during the advent of covid-19, hygiene priority is still not optional. The in-service training of zoo workers is another goal to achieve wildlife management success in recent time due to wildlife population decline in the wild, and captive wildlife protection and breeding have been resorted to. Collaborative management of wildlife species and their population is a conservation recommendation that would produce positive results in countries like Cameroon..

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