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Theme: Innovation in Enclosure Designing in Zoos

Innovations In Zoo Designing

Enclosure Design in Leopard Rescue Facility of Greens Zoological Rescue & Rehabilitation Centre, Jamnagar, Gujarat

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Introduction

Modern zoological institutions are no longer shackled by the dogma that defined them as facilities displaying animals for public viewing. Instead, zoos have evolved as modern conservation-oriented institutions that foster a sense of stewardship for biodiversity in visitors. To serve these goals, zoos and rescue centres should be designed so that they serve their respective societal roles for the animals housed as well as the visitors. Greens Zoological Rescue and Rehabilitation Centre (GZRRC) was founded with the objective to conserve global biological diversity, while catering to the welfare requirement of captive animals. GZRRC constituted a team of prominent zoo-biologists, who worked in close consonance with internationally acclaimed zoo-design firms to create enclosures and facilities to realize its short-term and long-term goals.

Greens Zoological Rescue and Rehabilitation Centre is cognizant of its responsibilities to the society and is guided by the principles of biodiversity conservation across all its activities. GZRRC aims to be one of the premier institutions in the field of conservation science by creating conservation-oriented infrastructure that caters to all stakeholders in our quest to conserve global biodiversity. Most zoo designers struggle to provide a usable captive habitat for animals, where they can express species-typical behaviour patterns. Modern enclosure design philosophy aims to create several opportunities for animals to experience species-

typical multi-sensory inputs (Clarke 2009). Animal welfare research frequently underlines the importance of the synergistic relationship between enclosure design and animal husbandry practices which together assists in providing optimum welfare to animals (Goswami et al. 2020). In this article, we will discuss some of the salient features of one leopard enclosure at GZRRC as a microcosm for our design ethos and conservation philosophy. This article will also highlight how the enclosure design of GZRRC is complemented by its trained animal management staff's efficient husbandry practices.

Overview of the Leopard Rescue and Rehabilitation Centre of GZRRC

The leopard rescue centre of Greens Zoological Rescue and Rehabilitation Centre is spread across an area of 24 acres and caters to the housing care and welfare of rescued leopards. This facility is designed for the welfare and long-term care of these rescued animals, but unlike most other commonly found rescue centres in the country, the enclosure design of the GZRRC facility stands out for its species oriented enclosure design. All enclosures at the leopard rescue facility apart from catering to the welfare of the rescued animals also aim to create several opportunities to express species-typical behaviours. Recent studies on the welfare of captive carnivores at Indian zoos show that enclosure complexity is one of the most significant contributors to the welfare of animals and has the ability offset the effect of visitor presence under certain circumstances (Estep, Fischer, and Gore 1978; Mallapur, Qureshi, and Chellam 2002; Goswami et al. 2023; Jensvold et al. 2001). Enclosure complexity and species-appropriateness are the guiding principles for the enclosure design at the GZRRC leopard rescue facility. Studies have shown that a complex enclosure increases the species-typical activity and reduces stereotypy in animals housed (Healy, Marples, et al. 2000).

Rescue and rehabilitation of animals is one of the primary objectives of Indian zoos as highlighted in the National Zoo Policy (1998). Greens Zoological Rescue and Rehabilitation Centre was founded on the principles of animal welfare and biodiversity conservation. Our core principles, reflect in the design philosophy of all enclosures and husbandry practices. The history of modern human civilization bears witness to the large-scale socio-economic upheavals marked by global changes in land-use patterns, causing habitat loss for several species of wildlife and an exponential increase in man animal conflict (Malviya and Ramesh 2015). Since the last few decades, the amount of conflict faced by the urban and semi-urban centers have spiralled to unprecedented levels (Inskip and Zimmermann 2009; Anand and Radhakrishna 2017). Increase in captive leopard population at Indian zoos because of man-animal conflict is a matter of concern. As the population of captive rescued leopards rises, Indian zoos are faced with significant strain on their limited off-display housing and human resources to care for these animals. Greens Zoological Rescue and Rehabilitation Centre, Jamnagar has a core objective to decongest Indian zoos by providing long-term welfare centric housing to animals rescued as a part of man-animal conflict. The GZRRC satellite leopard rescue facility provides one of the finest housing and captive management facilities for leopards that is unparalleled and peerless in its design and functionality. The leopard rescue facility has been operational since 2020 and continues to care for rescued leopards using novel husbandry and management practices. GZRRC uses a holistic approach to enclosure design and species management at its facility. In this regard, our modern enclosures are complemented by a highly trained group of Animal keepers, Biologists and Veterinarians who work together to cater the health and welfare requirements of everyone under our care.

Salient features of the enclosure design at the leopard rescue facility

Indian zoos have one of the largest captive populations of leopards and yet our understanding about the behavioural ecology of leopards remains limited to mostly field based studies. The off-display rescue facility for leopards at the GZRRC provides a unique advantage to further our knowledge about the captive biology and the behaviour patterns of rescued leopards. The enclosures are designed to encourage natural behaviours in leopards while allowing for disturbance free observation by keepers and biologists through remote and passive monitoring systems. According to Gupta (2008), enclosures should be designed to be safe for animals as well as the people who take care of them. Hence, safety of keepers and animals is of utmost importance and reflects in all aspects of the enclosure design. The enclosure barrier is made with 304 grade stainless steel mesh which is complemented by hedges as a stand-off barrier. Observation areas have one-way viewing glass that reduces the amount of glare and allows keepers,

biologists, and veterinarians to observe animals without causing unnecessary disturbance.

There are four interconnected paddock areas. Each enclosure has two-night cells measuring 6.35m (length) x 6.3m(width) x 3m(height). The indoor areas are made from ferro cement and wood that act as good substitutes for natural substrates and provide a good balance between natural stimulation and effective sanitization practices. Four leopard enclosures are interconnected by two overhead wire-mesh tunnels suspended at 14ft or 3m from the ground, that allow leopards to move freely between the four enclosures. The enclosures are top covered with 304 grade stainless steel wire mesh with height of 4m which allows for the provision of climbing furniture and elevated pathways.

Landscape

Most zoo enclosures for carnivores are limited in terms of their landscape design. In the natural habitat, carnivores, especially leopards, encounter a diverse terrain feature, which may include different substrates, water bodies, rocky outcrops, stones, hills, and mounds. The landscape of each leopard enclosure pays meticulous attention to the behavioural requirement of the leopards while interacting with the enclosures. Since the leopard enclosures are top covered to prevent chances of accidental escape, there is a chance of heat getting trapped in the same throughout the daylight hours. The wire mesh used in the leopard enclosure has a special reflective coating on the outer surface so that it reflects most of the radiated heat and prevents the temperature inside the enclosure from increasing. Additionally, the wire-mesh at the upper parts of the enclosure have wider openings for better airflow along with a provision for overhead sprinklers. Sensors are provided at various parts of the enclosure that take one reading every minute and if there is a hotspot developing at certain parts of the enclosure, the designated sprinkler in that zone turns on automatically. The water sprinkling system is designed to regulate the amount of water sprinkled based on the humidity levels inside the enclosure. By using this system, the water consumption levels of the enclosure have been optimized.

Barrier design

The primary enclosure barrier at the leopard enclosure is stainless steel wire mesh, which is complemented by hedges on the inner side of the enclosure. Certain areas of the enclosure are designated as observation points because they provide an unhindered view of the enclosure; these areas have one-way viewing glass as the primary barrier. Keepers, biologists, and veterinarians use these areas to observe animals and mitigate the observer effect McDougall (2012). Therefore, the barrier at the facility serves not only to prevent animal extrusion but also helps maintain the thermal gradients of the enclosure so that the animals can thermoregulate effectively. The enclosure barrier design at this facility is highly functional and caters to the welfare requirement of the species housed in the same.

Special Enclosure Features

In this section we discuss some of the prominent enclosure features of the leopard rescue facility that sets it apart. GZRRC uses cutting-edge technology to cater to the welfare needs of rescued leopards. Modern technology in-grained with welfare oriented design principles and a modern husbandry practice, are the key tenets for captive animal husbandry and management at the GZRRC.

Water sprinkler system

The enclosure is integrated with a multi-sensory system that logs the temperature and humidity levels of the enclosure periodically. Sensors are provided at various parts of the enclosure that take one reading every minute and if there is a hotspot developing at certain parts of the enclosure, the designated sprinkler in that zone turns on automatically. This allows for the expression of natural behaviours in the leopards and also promotes vegetation growth. The water sprinkling system is designed to regulate the amount of water sprinkled based on the humidity levels inside the enclosure. By using this system, the water consumption of the enclosures has been optimized. Additionally, the wire-mesh at the upper parts of the enclosure have wider openings for better airflow along with a provision for overhead sprinklers. The water sprinkling system is designed to regulate the amount of water sprinkled based on the humidity levels inside the enclosure. By using this system, the water consumption levels of the enclosure have been optimized.

Artificial Intelligence (AI) for security sensors glass

Safety and security of the animals and the personnel is one of the primary enclosure design features that resonates across the GZRRC. The enclosure is embedded with several sensors that prevent intrusion as well as extrusion. Artificial intelligence based face recognition devices are placed at all entry points to the facility as well as the night cells, so that only authorized personnel can gain entry. Additionally, sensors are installed at strategic locations of the enclosure barrier to ensure that an alert is issued as soon as there is an animal escape. All these modern, digital, AI based technologies help us ensure the safety and security of personnel and the animals.

Face recognition device (security features)

Movement of personnel across several enclosures has serious security, health, and safety repercussions. Hence the GZRRC has installed and implemented a site wide, AI based face recognition based access interface. Using this only authorized personnel can gain entry into their respective areas of operation. This mitigates disease transmissions and effectively reduces the risk of biosecurity breach.

3600 Overhead Tunnel

One of the unique features of the leopard holding facility is an innovative 3600 tunnel that connects four enclosures and crosses over one another. ***"Leopards are solitary animals and do not like the company of their conspecifics",*** our enclosure design puts to test one of the most prevalent dogmas of animal behaviour that has percolated into zoo biology as well as modern captive animal management. Four enclosures at our rescue facility house 16 leopards (8:8:0:16), all sub-adults. These four enclosures have an overlapping 360-degree overhead walkway design that offers leopards the choice to utilize two enclosures or use the hanging overhead tunnel to view areas beyond the enclosures. These walkways are designed to provide an unrestricted view of the surrounding landscape to the leopards and provide them a sense of control. This enclosure design, while innovative, also provides an unprecedented opportunity for biologists to observe and understand the social dynamics of sub-adult leopards housed in iso-sexual groups.

Vegetation at the enclosure

A functional captive habitat needs to be complemented with diverse species-typical vegetation that mimics nature and promotes the expression of species-typical behaviours. Most enclosures at Indian zoos are lacking in terms of a diverse vegetation design and distribution. The GZRRC has given special attention to the vegetation inside each enclosure, the leopard enclosure has more than 145 species of shrubs, herbs and grasses that are planted at various areas to promote natural behaviours like stalking, resting, playing and other prosocial behaviours. The vegetation inside the enclosure, especially trees, are linked with enrichment interventions. The keepers are trained to incorporate enrichment interventions such as sensory and manipulable enrichment with the vegetation to make the enclosures more functional for the animals. Keepers and biologists also collect regular samples to check for ectoparasites, on a weekly basis so that the vegetation inside the enclosure does not promote disease transmission.

Night-house design

Night cells at most Indian zoos seldom account for keeper safety in their enclosure design and management practices. In contrast, animal caretaker safety is at the core of the enclosure design principles at the GZRRC. The keeper gallery at the facility is 3m wide and provides sufficient space to care for the animals without risking injury. The keeper gallery has a separate room for remote monitoring of animals. Separate rooms are provided for food processing which reduces contamination during food distribution. Special attention is given to provide multiple enrichment opportunities to animals throughout the day, which includes the retiring cells. The night cells and paddock areas are equipped with CCTV monitoring system that allow 24x7 remote monitoring of animals. The night cells are designed to provide optimal spaces for the expression of species-typical behaviours. Each night cell is equipped with ledges and climbing structures as well as vantage points that allow leopards to perch naturally. Additionally, the night cells are equipped with multi-sensory enrichment devices that promote the expression of species-typical behaviours. The night cells are equipped with remote monitoring systems like night vision cameras and bio-fencing. These systems allow keepers to remotely monitor all night-cells without disturbing animals, while preventing chances of accidental animal escape or intrusions by alerting the security personnel. Strong odours and poor ventilation are one of common problems in night house design for most enclosures in Indian zoos. At GZRRC, all night houses have a high-power Heating ventilation and Air Condition (HVAC) system that works on a 24x7 power backup from renewable resources. The animals are provided with a temperature controlled living and resting space that is both sanitized and free from airborne pathogens.

Food chute and auto-filling water bowls

Keeper safety and animal welfare are two primary objectives of the design ethos at the GZRRC. Keepers are trained to practice all safety and security protocols while performing all aspects of their duties, especially when they are in close-contact with animals. Feeding large carnivores is a complicated task and mandates adherence to health and safety protocols. To ensure the safety of keepers and prevent contamination, food chutes have been placed at each retiring cell, which allows keepers to deliver the food to animals in a safe and hygienic manner. Auto-filling water bowls work on a simple mechanical design that fills up as soon the bowls are 70% empty. This prevents water wastage and allows animals to drink based on their physiological needs.

Squeeze cage tunnel

Squeeze cages are often necessary to conduct routine health examinations, apply prophylactic medications and perform other husbandry practices. However, squeeze cages elicit a lot of negative behavioural feedback from most zoo-housed animals. This results in a high incidence of injuries while coaxing animals to voluntarily move inside the squeeze cage. At the leopard enclosure, squeeze cages are placed between the doors of the night cell that opens to the paddock area, therefore the animals get habituated to the confines of squeeze cages every day. The keepers and veterinarians can also conduct quick ocular checks on the body condition, coat condition and the health status of the animals every day, due to this design feature.

Physiological measurements are crucial to captive management of animals. At GZRRC, diets and nutritional supplements for animals are adjusted regularly based on the body weight and physiological condition of the animals. All enclosures are equipped with weighing scales near the squeeze cage tunnel, which allows keepers to maintain daily records of weight of animals, which is used by our nutritionist veterinarians to measure the diet. Accurate weight information is also necessary to accurately deliver prophylactic treatments and detect physiological ailments before other symptoms arise.

Night house enrichment

Leopards housed at the rescue facility have the choice to spend their time at the retiring cells or at the paddock area. Hence the retiring cells or night houses should have the same level of opportunities as the paddock for animals to express natural behaviour patterns. Several natural perches and elevated platforms are placed at multiple areas of the retiring cell, where the leopards can consume large pieces of bones for prolonged durations. Increasing the amount of food processing time is an excellent way to reduce boredom and stimulate captive animals to express species-typical behaviours. Tactile rubbing posts, scratching posts and other multi-sensory enrichment tools are placed at each leopard enclosure. The enrichment devices are designed to target a set of unique behavioural traits that lead to the expression of unique species-typical behaviours.

Animal caretakers and zoo biologists regularly monitor the reaction of a leopard to particular enrichment and readjust their enrichment strategy to meet the welfare goals based on the welfare parameter objectives.

Animal welfare is a primary objective of the GZRRC and that reflects across all aspects of enclosure design and management practices. The enclosure at the leopard rescue facility is designed to provide sufficient opportunities for leopards to express species-typical behaviour patterns. Several enrichment features have been incorporated into the enclosure design which cater to the welfare requirement of leopards.

Leopards are cognitively diverse generalists, hence need constant challenges to mitigate boredom and

prevent displacement behaviours. The leopard enclosures allow them to express a full gamut of behavioural repertoire and instinctive behaviours which not only ensures welfare but opens opportunities to experience positive affect.

Hence keepers are encouraged to incorporate cognitively challenging enrichment for leopards. All enclosures have water ponds with variable depths that increase the complexity of the enclosure and mimic the natural environment. Leopards are among the most ubiquitous large carnivores found in the Indian subcontinent. Their natural behaviour repertoire consists of interacting with their habitat in multifarious ways, hence our enclosures are designed to provide similar opportunities to the animals and create sufficient chances for expression of species-typical behavioural repertoires. The enclosures are designed to increase the aesthetic and functional value of the captive habitat for the animals housed in them. The water ponds are further enhanced by the addition of a simulated waterfall which allows leopards to interact with their captive habitat in various ways. Leopards, like most large carnivores, prefer to rest on elevated perches that allow them to have a vantage point. Several such opportunities are made available to animals at the leopard rescue facility. Apart from elevated perches, the leopards have access to arboreal walkways that allow them to use their special climbing skills and access different parts of the enclosure.

Husbandry practices

Any modern enclosure should be designed while keeping in mind all stakeholders viz.,

1. The animal is housed in the facility.
2. The keeper takes care of the animals inside the facility.

Central Viewing gallery

The keepers have strategic viewing access to all parts of the enclosure allowing them to monitor the animals without causing unnecessary disturbance. The keeper gallery is specially designed to provide adequate space to the keepers for tailoring the daily feed of individual animals. Keeper convenience and safety is given utmost importance on each aspect of enclosure design. The GZRRC is a fully digitized facility with an emphasis on a fully integrated software based behavioural monitoring and species management system. Our animal keepers are trained to use the TRACKs software management system and input behavioural data for individual observations regularly which is monitored by biologists and veterinarians for further analysis and assessment. The GZRRC implements a welfare-centric husbandry and management program that is focused on minimizing the stress associated with daily husbandry practices. Animals housed at our facility are trained using positive reinforcement conditioning so that they volunteer for daily checks, which include oral cavity check, blood draws and prophylactic interventions.

Feeding practices

Leopards housed at the rescue facility are fed once a day with one fast day every week. The daily diet of leopards varies between 4-6 kg of meat with bones along with the necessary supplements. The diet is tailored to meet individual requirements, so that the meat is provided as uncut pieces along with bones and hide to promote natural food processing behaviours. A special food chute has been installed at each retiring cell that allows keepers to provision the food without having to physically enter the enclosure. All night houses have auto-filling water bowls that supply clean water. The floor of the retiring cells has a slight slope towards the keeper gallery to aid in the cleaning of the cells. Apart from the daily ration, the leopards are provided with supplemental feed based enrichment items like buffalo tail and dressed chicken that allow them to express species-typical behaviours.

Social grouping of animals

Common misconceptions about solitary-living animals often percolate into captive biology. Leopards at Indian zoos are often housed singly or in pairs, which inevitably leads to agonistic interactions due to improper management practices. At GZRRC, subadult and adult leopards are socialized gradually before they are released in the same enclosure. Post-release occupancy studies are conducted to understand the space usage patterns and the social-affiliative behaviours of the animals for three to six months. In this regard, we have found that the rescued leopards are able to live in harmony with minimal agonistic interactions if the management practices are designed to meet the individual requirement of the species.

Welfare outcomes

As per recent literature on enclosure design, enclosures should be designed to meet species-specific requirements, but they should be tailored to meet individual welfare requirements (Wolfensohn et al. 2018; Goswami et al. 2020). The leopard

enclosure at the GZRRC rescue facility has been designed to provide a multi-layered gamut of sensory inputs that not only provides an optimized level of welfare, but also promotes chances for experiencing positive affective states in rescued leopards. Since the rescued leopards have been transferred to the GZRRC rescue facility, we have noticed significant improvements in the level of species-typical behaviours shown by the animals. The GZRRC has an experienced team of animal-keepers, zoo-biologists and veterinarians that regularly monitor the behavioural and physiological correlates of welfare and make necessary changes to the husbandry practices to promote the expression of species-typical behaviours. Additionally, the keepers are trained to look out for displacement behaviours and record the same in pre-formatted data sheets, which are then analysed by biologists to identify preliminary symptoms of stereotypy in individuals. The enclosures at the GZRRC are designed to mimic natural habitats that are ever changing and mutating along with the seasons. These enclosures can be modified based on the unique species-typical requirements and provide animals with the necessary multi-sensory inputs required to express a species-typical behaviour repertoire and experience positive affective states. We discovered that since the leopards arrived at our facility, their body condition scores improved which was followed by an improvement in the physiological and behavioural markers of chronic stress. This is indicative of the fact that the enclosure design at the GZRRC caters to the welfare requirement of leopards. We hope that some of the salient design features mentioned in this article, diffuse into modern enclosure designs at Indian zoos, which will aid in the long-term welfare and health of animals housed in them.

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