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Wildlife Institute of India

केन्द्रीय चिड़ियाघर प्राधिकरण
Central Zoo Authority

Enrichment Manual for Selected Species in Indian Zoos

March 2016

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The enrichment devices suggested are prototypes made from easily available material. It is advisable that natural and sturdy material is used for construction of such devices.

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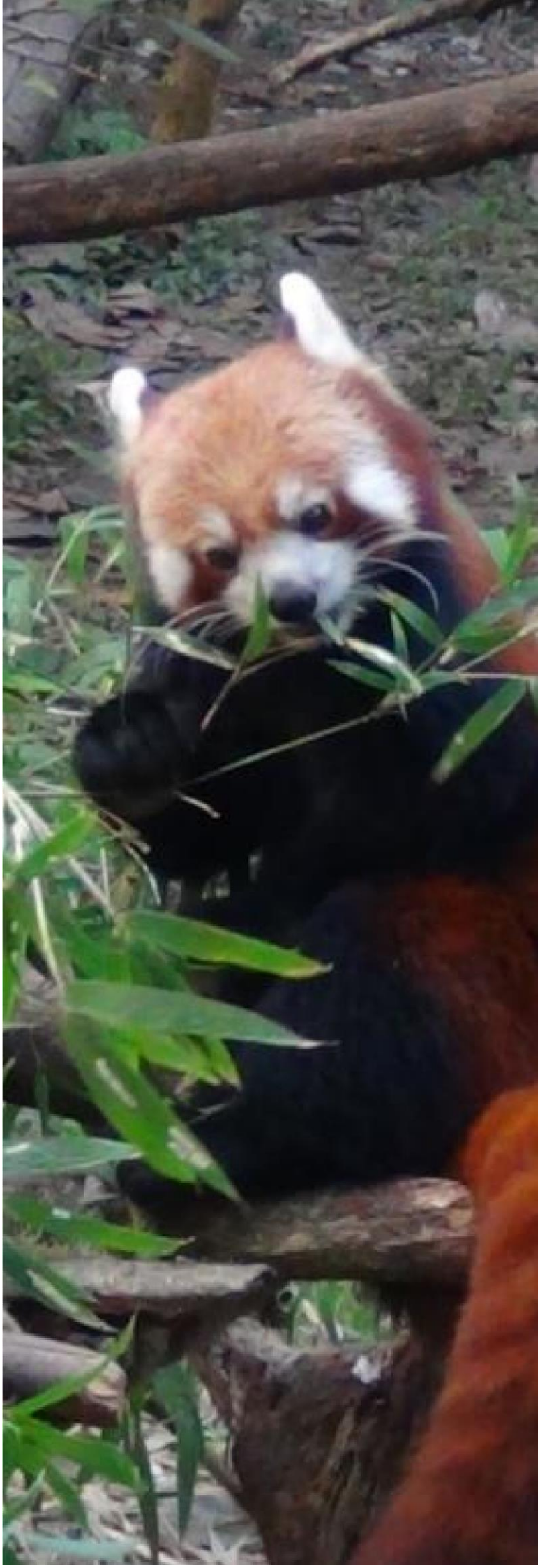

प्रकाश जावडेकर
Prakash Javadekar

सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
MINISTER OF STATE (INDEPENDENT CHARGE)
पर्यावरण, वन एवं जलवायु परिवर्तन
ENVIRONMENT, FOREST & CLIMATE CHANGE
भारत सरकार / GOVERNMENT OF INDIA

Message

Enrichment Manual for Selected Species in Indian Zoos TR No. 020 pp 161

Modern zoos in India have evolved over a period of time from menageries to centers of conservation and education. The Government of India in order to provide the desired direction and thrust to the zoos, amended the Wildlife (Protection) Act, 1972 and created the Central Zoo Authority in 1992 and notified the revised recognition of zoo rules in 2009. These rules lay down the standards and norms for housing, upkeep and healthcare of animals. The National Zoo Policy, 1998 advocates that the purpose of zoos is to support the conservation of endangered species through coordinated breeding and its rehabilitation in the wild, garnering empathy for wild animals by creating awareness, opportunity for scientific studies and to act as rescue centers for wild animals.

The Central Zoo Authority conducts regular evaluation and monitoring of zoos for granting recognition and facilitate improvement of zoos in consonance with the norms and guidelines. The animals housed in the zoos should be able to display behavioural repertoires as found in their wild con-specifics. The welfare of the animals is dependent on the presence of adequate space and enrichment in the enclosures. In order to evaluate the present housing and enrichment conditions in the zoos, the Central Zoo Authority (CZA) awarded a research project titled “Studies on Housing & Enclosure Enrichment of Some Species in Selected Indian Zoos” to the Wildlife Institute of India (WII), Dehradun. The primary goal of the study is to develop protocols on housing and enclosure enrichment for improving the welfare of captive animals.

The WII commenced the evaluations in January 2011 and carried out an extensive study in 24 zoos across the country addressing issues of animal housing and enclosure enrichment and prepared a detailed report on the prevailing housing and enclosure enrichment practices in zoos. The enclosure enrichment manual was developed based on empirical studies to improve the welfare of captive animals.

I congratulate the CZA and WII team for conceptualizing and executing this essential study and developing this manual in a short span of time. I exhort the zoos across the country

(Prakash Javadekar)

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to use the manual for improving their existing housing and enclosure enrichment practices thereby fulfilling their conservation mandates.

GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FORESTS & CLIMATE CHANGE
Central Zoo Authority

PREFACE

The Central Zoo Authority since its inception in 1992 by an amendment in the Wildlife (Protection) Act, 1972 has been facilitating the improvement and management of the zoos in the country. The welfare of animals is of primordial importance to the ex-situ captive facilities and can be achieved by constructing naturalistic enclosures and safeguards self-sustaining, genetically and behaviourally viable populations of species threatened with extinction in the wild. The maintenance of such populations is dependent on the ability of zoos to provide animals in their care with environment that fulfill their critical requirements. These vary between species, as well as between individuals of the species, and encompass the social structure of the animals, their physical environment, and even their vegetation.

Fulfilling these critical requirements has been a challenging task in the limited space available for housing wild animals in zoos.

The Wildlife Institute of India, Dehradun has initiated a study for captive animal welfare and conducted a rigorous review of literature on the natural history, biology, behaviour and ecology of these species to assess their critical requirements in captivity. It has further promulgated housing and enrichment protocols for the welfare improvement of the captive species.

Based on the findings of the study, a manual was developed for providing various enrichment options available for different groups of species. I am sure that this manual will be an important reference source for the zoo managers for execution of welfare measures suggested by the Institute. I appreciate the hard work done by the researchers in developing innovative techniques and enrichment methods for improving the welfare of animals in Indian zoos.

techniques and enrichment methods for improving the [illegible]

(Vinod Ranjan)
Member Secretary

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Delhi, assignment to the Wildlife Institute of India, Dehradun, for the project titled “Studies on Housing and Enclosure Enrichment of Some Species in Selected Indian Zoos”. The authors wish to thank the Central Zoo Authority for financial support and the opportunity to develop this manual.

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We are thankful to Shri. P.R. Sinha, Former Director WII, Dr. V.B. Mathur, Director, WII for their guidance and support. We would also like to express our appreciation for the advice and support extended by Dr. P.K. Mathur, Former Dean Faculty of Wildlife Sciences, WII. We also express our gratitude to all the faculty members and research personnel of the institute for their help and advice in carrying out the task assigned.

We express our heartfelt gratitude to all the Directors/Curators, Veterinary Officers, Biologists, and personnel of all the zoos for facilitating the completion of this work.

We also express our appreciation of the efforts put in by Ms. Nilofer Begum, and Mr. T. Ajay Kumar for their contribution in the initial phase of the project. We also thank Mr. Attar Singh, Mr. Mukesh Arora, Mr. Neeraj Gupta for the secretarial assistance provided.

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Introduction

Zoos receive almost 600 million people annually across the world and continue to be one of the most popular venues for recreation. This large mass provides an opportunity to the conservation community to reach out and effectively convey the need for human society to develop a harmonious relationship with its environment.

Zoos of today serve as public institutions but they trace their origins as private collections of the royalty and the rich across the globe, and India is no exception. In India the earliest record of zoos can be found during the Gupta era (320 AD – 467 AD) with enactment of laws for the management and welfare of captive and wild animals. However, the first public zoo in India was established by the then Governor General Lord Wellesley at Barrackpore in 1800 AD. This zoo continued till 1878, when the collection was handed over to Alipore Zoological Garden, Kolkata. Later, Zoos were established at several locations across the Indian subcontinent. The animals in these zoos were housed in cramped barred cages with little space for movement and little consideration for their behavioural or nutritional needs. During this period hunting was extensively practiced both for sport and sustenance and animals were easily available for zoo collections. Expanding anthropogenic activities resulted in habitat degradation of wild fauna, thereby causing large scale population declines. The non-availability of wild animals forced zoos to try breeding programmes for animals in their custody..

In 1952, the Indian Board of Wildlife (IBWL) (now the National Board of Wildlife) was constituted with a view to preserve the country's rich natural heritage. The establishment of a modern zoo at Delhi with large natural looking enclosures was one of the important decisions taken in its first meeting. The zoo at Delhi was planned with view to provide animals with semi-natural conditions and a better viewing perception for the visitors by doing away with visible barriers as far as possible. IBWL also recommended the establishment of modern zoos at major cities as

a means of educating the public about wildlife and wildlife conservation. The Delhi zoo was opened to public in 1959 and it was followed by several zoos across the country. The zoos of the erstwhile royalty were also taken over and opened to the public with a gradual shift from the menagerie concept to the large naturalistic enclosures.

In 1972 the zoo wing of the National Board of Wildlife was re-constituted as the Expert group on zoos with the mandate to carry out a detailed study for setting up and establishment of zoos in the country. This led to the establishment of several wellplanned zoos with spacious enclosures across the country; however, the zoo movement also witnessed the proliferation of several ill-planned zoos with poor infrastructure. Central Zoo Authority was constituted in 1992 to oversee the functioning of zoos and control mushrooming of poorly conceived and ill-planned zoos. The framing of the Recognition of Zoo rules 1992 under section 63 of the Wildlife (Protection) Act, 1972 paved the way for introduction of standards and norms for management of zoos in the country. The Government of India in 1998 adopted the National Zoo Policy to provide the necessary direction and thrust to the management of zoos in the country.

Central Zoo Authority defines zoos as:

> ‘Zoo means an establishment, whether stationary or mobile, where captive animals are kept for exhibition to the public and includes a circus and rescue centres but does not include an establishment of a licensed dealer in captive animals’.

A zoo comprises of four integral components – the animals, the visitors, the personnel looking after both the animals and the visitors, and the infrastructure required to support the earlier three.

The CZA over the years has continued to exhort zoos to improve the existing housing and husbandry conditions for captive wild fauna with respect to its mandate. As part of this endeavour the CZA has prescribed minimum areas for paddocks (outdoor areas) and retiring cells for select species. The continued evaluation and monitoring process of the CZA revealed that while the zoos were adhering to the minimum area prescriptions, the zoos were not going beyond these to improve the housing conditions of the animals in their care.

Role of Zoos in Conservation

Zoos can further their conservation mission by maintaining demographically stable and genetically viable populations of species threatened with extinction. Animals housed in enclosures that provide opportunity to express their natural behavioural repertoire can assist in fulfilling this objective of zoos. Exhibiting healthy (behaviourally and physically) animals in near natural surroundings is also an effective way of creating empathy in the mind of the large number of visitors entering zoos. It also ensures that the population so developed will successfully reproduce and adapt to *in-situ* conditions as and when suitable habitats become available for reintroduction.

Conditions in Captivity

An animal's environment includes all internal (e.g. parasites) external (e.g. social interactions) and non-hereditary conditions under which an animal lives. Species have evolved to occupy niches in the habitats in which they occur with the level of adaptations varying in each species. Some have evolved specializations which are unique to particular habitats while others are more adaptable and survive in a broad range of habitat types. Free ranging animals thrive by achieving control over their environment via regulatory behavioural adjustments. In captive conditions an animal loses this control over its environment as it is impossible to include the infinite variables that exist in free ranging situation. Conditions in captivity are therefore often stressful, especially for species about which little is known about their environmental requirements and behavioural ecology from studies in free ranging condition.

Effects of Captive Environments

Animals are equipped with psychological and physiological adaptive mechanisms to cope with various environmental stimuli encountered. These mechanisms have evolved over generations and enable animals to adapt to their habitat and exploit it to ensure their wellbeing. Michelson and others in 1995 proposed that the balance between an animal and its environment could be termed as homeostasis and any change in the environmental condition that disturbs this homeostasis, as a stressor. Dantzer in 1991 defined stress as 'the experience of having intrinsic or extrinsic demands that exceed an individual's resources for responding to those demands'.

In their natural habitats, animals are free to express species-typical behaviour patterns that form a unique part of their life cycles. In

wilderness, when faced with adverse environmental conditions, animals can move from their present location to a more suitable environment. However, in captive conditions, animals cannot move away from stressful situations compromised welfare.

Animals housed in environments that poorly address its biological and behavioural requirements are subjected to stress by the altered environmental conditions. Additional stressors in the form of visitors and various other aversive stimuli such as noise, altered photoperiods etc. are present in captive environments. Response to these stressors varies between species and individuals history. Some species and individuals may adapt well to the captive environments while others may undergo chronic or acute stress depending on the stressor and the individual. Animals born in captive environments are less susceptible to these stressors than wild origin animals.

These stressors which can cause acute stress in wild origin individuals may hardly elicit any response from the captive born individuals.

Effect of Stressors on Captive Wildlife

Commonly observed stressors and the responses elicited are summarized below.

1. **Restrictions of space/ movement:** Most animal species traverse large daily distances to fulfil critical needs of finding food, water, cover and mates. While moving around their home ranges/ territories, animals exhibit a diverse pattern of behaviours in response to the wide variety of stimuli that they encounter. Captive environments constrain the space available to the animals and provide monotonous environment with limited stimuli. A consequence of the limitations of space and stimuli in animals' results in a variety of abnormal behavioural patterns that may often become repetitive leading to stereotypies.

Plate 1: Bonnet macaque in restrictive cage enclosure

2. **Uniformity and fixed schedule of zoo diets:** Wild animals show seasonal variation in food choices depending on resource availability. Further most of the extant animals have evolved to exploit specific niches and seasonal variations in resource availability in their ecosystems and have developed specific adaptations that ensure their effective utilization. They have also developed unique feeding strategies that ensure effective predator avoidance for prey species and prey availability for predator species. The strategies used also ensure the avoidance of diurnal weather extremes, such as avoidance of high noon time ambient temperatures. Most captive feeding regimes are however constrained by fixed feeding schedule and provision of resource rich processed feeds that can be consumed in a short while. This is contrary to that experienced in free ranging condition where resources are often spread over a

large area and animals have to seek these resources thereby spending a large part of their daily activity budget in locating and consuming food. The altered feeding regime leaves the animal with a large amount of inactive time and can lead to animals developing feeding related behavioural disorders such as regurgitation and re-ingestion of food, coprophagy and feeding related stereotypies besides physiological disorders like obesity.

Plate 2: Processed food given in zoos

3. Improper Social Grouping of Animals:

Sociality is a complex behaviour that has variably evolved across the diverse animal types. Social structures facilitate communication with conspecifics, reduce aggression and aid in mate selection. This is ensured by a complex social structure observed for most species in the wild. The group structure of all species varies dynamically throughout the year as sub-adults turn into adults and disperse into neighbouring territories. Even solitary species exhibit a range of social behaviours that have their cues in olfactory, auditory and visual cues that are used to reinforce territoriality and announce their reproductive status.

In captivity, animals are often housed contrary to their normal social structure in free ranging condition. Consequently the

presence/ absence of conspecifics place the animals under continuous stress with varied behavioural and physiological and behavioural responses.

Plate 3: Social group of lion-tailed macaque at Arignar Anna Zoological Park

Plate 4: Singly housed Stump-tailed macaque at Assam state zoo

a variety of behavioural abnormalities such as lethargy;

4. **Constant exposure to visitors:** The zoo environment places animals in close proximity to human beings, in the form of keepers and visitors. Animals housed in enclosures that have small distance between the visitors and the animals can place animals under undue stress. This chronic stress can lead animals to express using only the elevated portions of the enclosures that place them above the visitors; stereotypic pacing at portions of their enclosures furthest from visitors often resembling efforts to escape.

5. **Barren enclosures:** Free ranging animals inhabit dynamic environments that provide varied stimuli and exhibit a diversity of behavioural patterns in response to these stimuli. Captive environments due to limitations of space are unable to provide these diverse stimuli; however, enclosures that lack the minimum environmental requirements of the species in captivity can cause severe irreversible behavioural changes in the animals housed. An example of this is primates housed in an enclosure without trees and elevated perches will exhibit locomotory disorders and

develop morphological abnormalities as a consequence of walking on hard ground. **Plate 5:** Barren retiring cells

Compensating for Stress

Providing captive animals with living spaces that counter the stressful effects of their environments is an enormous challenge requiring intensive rethinking in the way enclosures are designed, retrofitting existing enclosures as control, choice and decision making are critical biological needs of any animal. Providing animals with these options in captive environments is indeed challenging and can be done by providing naturalistic environments and enrichment that caters to the unique requirements of the species and the individuals. This will enable captive animals to display behavioural patterns that are in close approximation to their natural behaviours.

Naturalistic Enclosures

The meaning and scope of animal welfare in broader views, can be leading a natural life through the development of natural capabilities. To achieve this end the perfect zoo enclosure would have to be an exact replica of the territory the species occupies in the wild. This would be possible only for a few select species for most of the others the space requirements and the costs of such enclosures would be prohibitive limiting the range of species that can be maintained in captivity. The aim of captive management of wild animals is therefore to create an illusion of naturalness in captive environments. For this purpose the terms 'Natural, Naturalistic and Naturalistic exhibit' are used by the zoo community. Zoolex defines these terms as:

Natural: Existing in or produced by nature; not artificial or imitation.

Naturalistic: Representing what is real, aiming at replicating a natural environment.

Naturalistic exhibit: The exhibit represents a natural animal habitat in a convincing way.

Zoo exhibitory has accordingly evolved from the menagerie concept of living natural history museum exhibits to creative exhibits that strive to educate visitors about biology, ecology, threats to biodiversity and other environmental issues. The requisite message of the interdependence of animals and their ecosystems can be best explained by naturalistic enclosures that aim to recreate the relationship of the animal with its environment. Exhibits housing animals in improper social groups and poor ecological context can lead to the creation of a distorted view of the environment. The educational objectives of the exhibits can be achieved by incorporating the species natural history, ecology and behaviour into the design process. However, enclosures need to be serviced and the visitors need to see active animals. Zoos without visitors will not be able to operate for long and without being serviced, the enclosure sanitary conditions would rapidly degenerate. The perfect zoo enclosure should therefore cater to the occupants needs and cater to the needs of the staff that are to service it and the visitors who will view it.

Animal welfare should be the first priority of zoo management. Animal enclosures should provide enough space so that the animals within do not feel threatened (the flight distance is considered). This need not necessarily translate as enclosure with very large areas as even extremely large barren enclosures would not address the basic biological needs of the species. The enclosures should be large enough to incorporate features that provide animals a flight distance *i.e.* to feel safe when threatened; an area to rest undisturbed in addition to features that address the basic biological and ecological requirements of the species. From the keepers perspective the enclosure should be easily serviced; they should be safe from the animals; there should be an area for restraining the animals for daily servicing and maintenance.

The visitors pay to see active and healthy animals in what they perceive as the natural environment of the species. The visitor needs can be met by incorporating enrichment programmes in the husbandry protocols to ensure that animals remain active for a large part of the day. A variety of behavioural choices should be made available and the greatest challenge is to encourage species-typical behaviours without reverting

to the use of objects from the human world or to symbols of human dominance and control.

Exhibits cannot say everything by themselves, but they must be designed with conservation messages in mind supported by appropriate signage that conveys the message the enclosure is expected to impart. This is important as most visitors construct their own meanings from what they see. The physical context being offered is just one of many factors involved in the construction of these meanings. By doing so we may strive to achieve the one of the most important mission of zoos i.e. to create empathy in the minds of the visitors towards conservation of nature and its diverse resources.

Enclosure Enrichment

Attempts to address abnormal behaviours led to the concept of keeping the animals busy with activities leading to positive outcomes using enclosure enrichment. Enrichment of captive animals is essential for avoiding abnormal behaviour, it may not make it stop completely, but will help stimulate the animal. Markowitz and LaForse in 1987 suggested that **"Behavioural enrichment is the art of designing and offering behavioural opportunities for captive animals to exercise species-typical behaviours and, where possible, to mirror opportunities found in nature"**. It is through the careful analysis of an animal's enclosure and behavioural enrichment that we may begin to avoid abnormal behaviour.

Environment Enrichment in Captivity

Animals in captive conditions do not have the freedom to perform instinctive behaviours that they usually display in the wild, this leads to stress. In order to remove the stress, environmental enrichment can be placed in enclosures, which allow animals to display a higher proportion of their behaviour repertoire. Enclosure enrichment is defined as "Provision of stimuli which promotes the expression of species-appropriate behavioural and mental activities in an under stimulating environment."

Enclosure enrichments are management interventions that are made to help captive animals display natural behaviour patterns. Animal housed in natural enclosures that allow species-typical behaviours live longer

and are less susceptible to diseases. Therefore, zoos need to implement enrichment plans for each animal species housed in the zoo. Scientists obtain information about basic ecological and psychological requirements of species from field studies and use that information to simulate conditions in captivity that creates opportunities for species-appropriate behaviour in enclosure environments.

Rationale for Enrichment

Major philosophies behind enrichment are summarized below:

Mimicking Nature

Animals have evolved to thrive in a specific set of natural environments; thus, by definition, in nature the animals' needs are met satisfactorily. An extension of this is, if an animal that behaves in captivity the same way as it would in the wild, it is assumed to be in a good state of well-being. This philosophy is beset with the difficulty of defining "natural behaviour" in a species with diverse habitats and the problem of deciding which behaviours and environmental stimuli are "good" and which are "bad" and the fact that most animals are capable of learning to adapt to novel environments.

Behavioural Needs

The philosophy is that animals have evolved complex patterns of behaviours, and that they have a "need" to perform these behaviours. The absence of either the ability to perform those behaviours or the stimuli needed to elicit them can result in frustration and ultimately stress. Several studies in captivity support this concept.

Control/ Behavioural Contingency

Control can be defined as the probability that a certain outcome will occur in response to a given behavioural interaction. This control is important for animals to maintain homeostasis with its environment such as the acts of regulating body temperature, avoiding stress inducing stimuli both physical and psychological.

Reducing Abnormal Behaviour

Most abnormal behaviours seen in captivity are associated with reduced well-being of captive animals and the most commonly reported

abnormal behaviour is stereotypy. The stated goal of most enrichment programmes is thus a reduction in expression of abnormal behaviours.

Increasing Behaviour Diversity

The behaviour diversity exhibited by captive animals is usually less than that of animals in the wild, and is also an indication of behavioural opportunities and degree of control. Increasing behavioural diversity is thus another mechanism for evaluating the effectiveness of enrichment. In studies where behavioural diversity has been assessed, enrichment has been shown to be effective at increasing it.

Increasing Duration of Specific Target Behaviours

Certain behaviour patterns associated with improved welfare conditions are targeted for enrichment. These can include exploratory and foraging behaviours, locomotion and play. The behaviours being targeted may vary for different species.

Increasing Enclosure Space Utilization

Several behavioural problems associated with captivity are believed to be a consequence of confinement or reduced space and the static nature of captive environments. The perceived space in captivity can be increased by creating a more complex environment thereby creating more usable space that actually change the physical space.

Reducing Physiological Correlates of Stress

Limited literature exists on the physiological aspects of stress with only a few studies evaluating physiological measures of stress are reported from captive wild animal facilities; however, the technology is becoming more practical and capable of providing quantitative results on physiological measures of stress.

Objectives of Enrichment

Enclosure enrichment is implemented for providing a more complex environment that gives animals' greater choice and control over their environment. Following are the stated objectives of most enrichment programmes.

1. Reduce aberrant behaviours
2. Alleviate stress related to captivity
3. Provision of opportunities to display species-typical behaviour patterns

4. House animals in near-natural conditions in ideal social group
5. Reducing the factors in the immediate environment that stresses animals
6. Increasing the activity level of animals

Enrichment Types

Enrichment of captive environments can be of numerous types depending on the natural behavioural traits of the species and the personality of the animal occupants. The major enrichment categories are summarized in fig. 1. However, these should not be treated as watertight boxes while implementation, indeed effective enrichment is most often a combination of multiple enrichment categories (e.g. Puzzle feeders are a combination of cognitive, sensory and food enrichments). Enrichment planning and implementation should involve preliminary assessment of the personality of the animals and species specific behavioural traits of the animals. Based on this assessment an enrichment plan for the individual animal enclosures should be prepared. The major considerations while implementing enrichments are that they should promote species specific behaviour patterns and the animals should continue to use them. These conditions can be met:

a. Enrichment planning based on knowledge of species critical requirements.

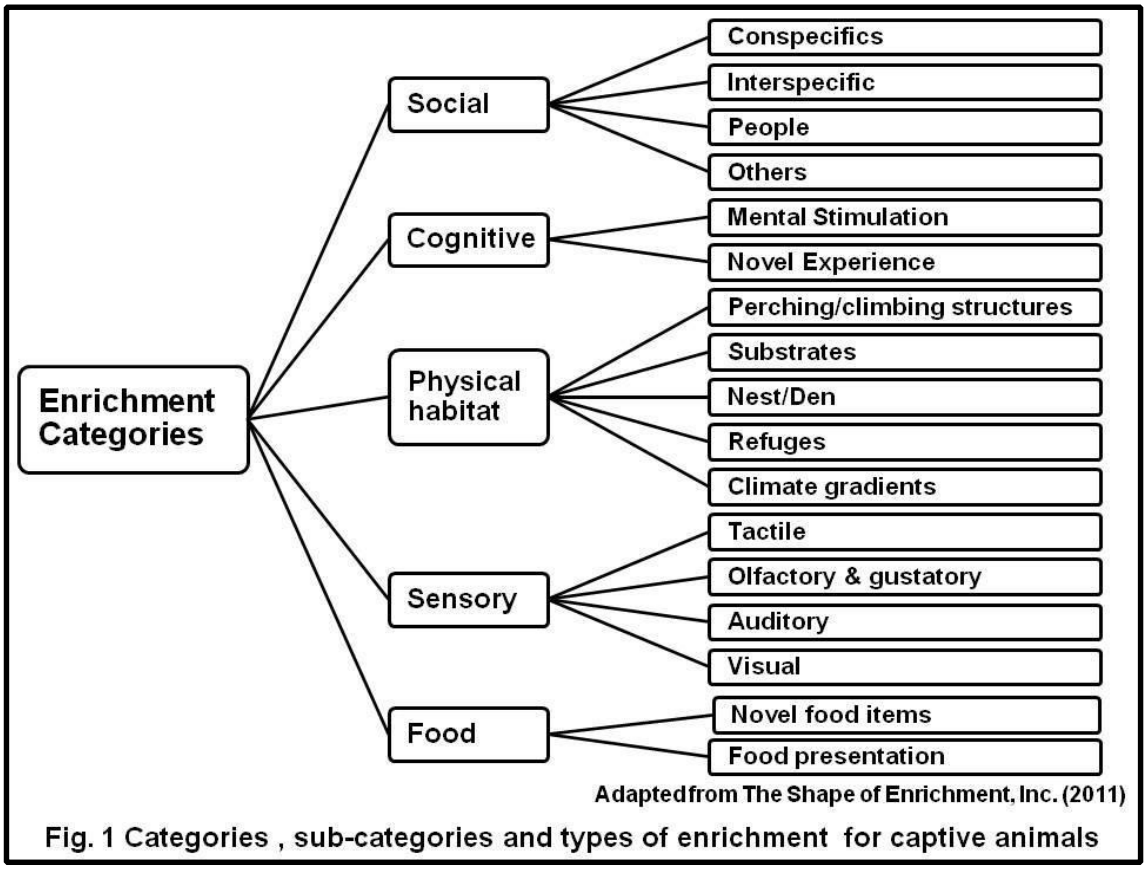
b. Enrichment plan includes a rotation of the artefacts and devices and an element of novelty is maintained.

Enrichments can be of many types *viz*., sensory, manipulable, nutritional etc. These broad categories of enrichments are designed to provide certain species-typical needs of every captive animal that is otherwise overlooked in captivity. Animal enclosures should be designed with three parties in mind

1. Animal
2. Visitor
3. Zoo staff

With this in mind, a zoo enclosure needs to be designed while keeping the ecological, biological and behavioural requirements of the species in mind.

Here we will discuss briefly about different types of enrichment and how these can improve welfare in captive animals.



Adapted from The Shape of Enrichment, Inc. (2011)

Fig. 1 Categories , sub-categories and types of enrichment for captive animals

Different Types of Enrichment Devices and Practices

a. Social Enrichment

It involves either direct or indirect (visual, olfactory, auditory) contact with conspecifics or other species or humans. It can include maintaining animals in appropriate social groups' e.g. Primates in troops comprising of multi-male – multi-female with young, similar social groupings can also be maintained for ungulates. Even for solitary animals like felids in the wild males defend territories which overlap with territories of one or more female and they remain in communication with each other through olfactory and auditory signals. The presence of human caregivers can in some cases also provide positive stimulus to animals such as elephants which share a strong bond with their mahouts.

a. **Presence of conspecifics (belonging to same species):** Animals housed in social groups are less likely to display abnormal behaviour patterns than those housed singly. Pair or group-housed animals spend a large chunk of time playing and socialising with each other.

b. **Appropriate social grouping:** Some group living animals have different types of social structures. For example, lion-tailed macaques usually have a very low number of males for all the females in each group. Therefore, it is advised not to house lion-tailed macaques in male-male iso-sexual groups or a high number of males per female, as this will lead to increased incidences of conflict in the enclosure.

c. **Presence of other species:** Several species in the free ranging condition have close interactions with other species that are mutually beneficial such as the association between herbivores and primates; mega herbivores with deer etc. Predator and prey species should never be housed together nor should carnivores that are likely to have mutually aggressive interactions

2. Cognitive Enrichment

It encompasses both psychological enrichment (e.g., devices that provide animals with control or challenges) and enrichment that encourages exercise. The continuous changes in an animal's environment require it develop behavioural mechanisms that allow it to cope with these changes and maintain control over its environment. Captive environments on the other hand provide unvarying monotonous environments that thwart this need of the animal. Providing devices that stimulate the animals to perform activities that provide it with a greater control over its environment and perform natural exploratory behaviours e.g. concealed food, puzzle feeders, mazes etc.

Food Based Cognitive Enrichment

a. Scatter Feeding:

Usually captive animals are fed in retiring cells with bulk feed that does not require much searching or processing. In the wild, animals have to run, track, hunt animals, climb trees

Plate 6: Olfactory Enrichment by brushing honey on rotten logs

Plate 7: Binturong scatter fed at Sepahijala conservation breeding facility

and swim in order to obtain food. In captivity animals have limited scope to express foraging behaviours. By scattering the feed in enclosures we can address following issues.

i. Increase foraging behaviour

ii. Enhance activity budget and improve cognitive abilities

iii. Reduces conflict at feeding site where one animal might dominate others iv. Encourages a more homogenous enclosure space utilization pattern

However care should be taken on the following points

a. Leftover food items might attract rats, mongoose and other rodents that spread disease. It should therefore be ensured that leftover food items should be cleaned every day.

b. Care should be taken so that the animals do not see the keeper during scatter feeding. Keepers should scatter the feed before releasing animals.
Keepers may also scatter the feed while hiding behind a screen.

c. Scattering of feed should never be done during visitor hours as this may encourage food provisioning by visitors that may lead to incidences of begging behaviour.

b. Food Dispensers: Food dispensers can be small devices that are loaded with delicious low-nutrient food items that provide a small quantity of feed at intervals. The devices can be simple or complex and can enhance the cognitive skills of animals and increase social cohesion in group-living animals.

i. Increase foraging time ii. Decrease boredom

iii. Reduce abnormal behaviours or site-specific behaviour

pangolin, insects constitute a huge portion of daily diet requirement. In captivity, it is very

before feeding time iv.

Increases social interactions in

species.

Plate 8: Asiatic Black bear with honey dispenser at Mahendra Chaudhury Zoological Park, Chatbir

Insect Feeders: For some animals such as sloth

c. bears and

difficult to replicate natural behaviours. Insect dispensers can be fashioned from rotten logs and impart a functional naturalism to the enclosure.

d. **Suspended Puzzle Feeders:** Suspended puzzle feeders in zoos increase the cognitive skills and mental acuity of captive

Plate 9: Ball feeder suspended

e. Concealed feeding

Concealed food items can be subterranean (hidden under the ground) or can be hidden in enclosure features (like tied to tree branches etc.).

These are occasional food rewards that can be given to an animal for exploring the enclosure environment

Plate 10: Hidden food items in the enclosure, Asiatic black bear digging out food items

animals. These puzzle feeders can be fashioned from various materials. The one shown in the picture was made from two baskets that were sealed at their opening. Holes were cut at the sides of basket so that keepers could load food and then the ball would be hung from a tree branch.

i. Food rewards should be placed at different locations ii.

The nutritive value of such treats should not be high iii.

The processing time for such treat should be low to minimize chances of conflict between enclosure mates.

3. Enrichment of Physical Habitat

It involves altering the size or complexity of the animals' enclosure or adding accessories to the enclosure such as objects, substrate, or permanent structures (e.g., nestboxes). Free ranging animals are exposed to extensive variation in the habitat they occupy enclosure for captive wildlife on the other hand offer limited variation in the microhabitat types. Providing variations in microhabitat types in the enclosures and by varying the location of different microhabitats periodically can stimulate exploratory behaviour in the animals. Additionally incorporating as many as possible features of the natural habitat of the species in the enclosure can provide animal with greater control over their environment. The features provided need not be the replicas of that occurring in the wild rather they should be able to cater to needs of the animals that features of their natural habitat provide.

Trees and enclosure vegetation have a cascading effect on the aesthetics and naturalism of the enclosure. By having species-specific vegetation in enclosures, we promote natural foraging and social behaviours in the species.

Applicable: These type of enrichments are ideal for all type of animals, provided the vegetation is non-

a. Trees and Enclosure Vegetation

Plate 11: LTM utilizing enclosure vegetation

toxic, does not have thorns and thistles and do not impede the natural behaviour pattern of the animals in any manner.

b. Trunks and Logs

Trunks and logs in enclosures enhance aesthetics of the enclosure and increase functionality of the paddock area, bringing variety to the simple terrain of the enclosure paddock area. These simple devices can be used to attract insects that increase foraging. Such trunks and logs can be manipulated by animals to forage on insects or play with enclosure mates. They can be used to hide food items and increase the complexity of the paddock area.

Applicable: Such enrichment devices are effective for ungulates, megaherbivores, small mammals, ursids, canids and primates.

c. Substrates

Substrate of the paddock area should be made from soil and keep the usage of concrete and cement to a bare minimum. A natural substrate is good for maintaining the claws of carnivores and ursids and helps animals perform natural behaviours. Natural substrate in the paddock area promotes vegetation growth and increases aesthetic appeal of the enclosure area. Natural substrate should constitute more than 75% of an enclosure area. Presence of natural substrates in enclosures can promote denning behaviour among canids during whelping.

d. Earthen Mounds (Undulating Terrain)

Apart from a few grassland species, most wild animals prefer mild undulations in the paddock area. Undulations need not be abrupt and should provide enough topographical variation so that animals have adequate withdrawal areas.

e. Water Pools

All animals need water to maintain homeostasis via hydration and thermoregulation. Water bodies are essential in every enclosure. Water bodies should be designed to meet species-specific requirements.

f. Visual Barriers

Individuals in adjacent enclosures may exhibit overtly aggressive behaviour.

The reason could be evolutionary (sambar and tiger) or social/territorial (between two male tigers, red pandas, macaques). Visual barriers are suggested for enclosures where the sight of animals in adjacent enclosure places the residents of the other enclosure in stress. Visual barriers can be made of artificial (if the animals are not in contact with the barrier) or natural (if the animals can interact with the substrate) and should not affect the visual aesthetics of the enclosure.

Plate 2: Asiatic black bear thermo regulating at water pool

g. Artificial Rain

For species living in tropical rainforest, temperate and alpine species held in zoos in sub-tropical and dry-deciduous areas artificial rain can cool ambient temperatures and moisten their arid environments thus making the enclosures more hospitable.

h. Enclosure Rotation

Enclosure rotation is a concept where in animals belonging to same group are housed in interconnected enclosures. After a certain time-period animals are shifted from one enclosure to the next interchangeably (Shuffling). Animals at the new enclosure are exposed to the smells and odours of other animals, get curious and explore their new habitat with species-typical behaviour patterns.

This also allows vegetation to regenerate in herbivore enclosures.

4. Sensory Enrichment

Providing enrichment that stimulates the visual, auditory, olfactory, tactile and gustatory senses of animals housed in captive environments. In their natural habitat wild animals are exposed to a variety of conditions that stimulate their sense organs and elicit species typical responses. Conditions in captivity are often monotonous with little variation in the stimuli received by the animal. Providing animals with sensory cues in captivity can stimulate species typical responses in animals and can cause a reduction in the aberrant behaviours exhibited by them.

Exposing prey species occasionally to the visual, olfactory or auditory cues of predator species can elicit predator avoidance behaviour in them. Exposing cold blooded animals to a range of thermal gradients can induce activity in them with the animals preferring to opt for the zones with optimum temperature range. Similarly scent from conspecifics can induce greater marking behaviour in territorial species.

Scent trails using appropriate activities such as foraging or eg.

Scent trails using blood acts as a cue to stimulate exploratory behaviour in carnivores.

Plate 13: Asiatic black bear using scent trail

a. Scent Trails

Several species use olfactory cues for communication and understanding their environment. The cues thus obtained stimulate appropriate behavioural responses in the animals. Scent trails are based on eliciting responses to olfactory stimuli. smells can be used to elicit exploratory behaviour in animals.

b. Conspecific Vocalizations

Vocalization of conspecifics can increase species-typical behaviours in captivity. This can be particularly enriching for animals born in captivity as this promotes territorial behaviours. These enrichments are not recommended for animals brought from wilderness. The vocalization of conspecifics can increase the curiosity of the animals but implementing such enrichment may cause chronic stress to the animals and can be counter-productive to animal welfare.

c. Predator Vocalizations

Predator vocalization playbacks in prey enclosures can be a novelty in relatively enriched enclosures; however, if the animals display begging behaviour at certain parts of the enclosure and seek food from visitors. Predator scent (urine) and predator vocalization playback can be used to ward off the animals and keep them alert; however, such enrichments can remain effective if used occasionally and fail on long-term sustained use. These enrichments can increase stress on animals to a great degree.

d. Thermal Gradients

Every species requires a certain variation in temperature to maintain its homeostasis. Cold blooded animals can have their environments enriched using varied thermal gradients that the animals can utilize for thermoregulation.

5. Feeding Enrichment

It involves either presenting varied or novel food types or changing the method of food delivery.Free ranging animals spend maximum part of their daily active times either feeding or searching for food; in captivity this urge is severely thwarted by the fixed

feeding schedule and altered diets. Natural feeding/foraging behaviour can be elicited by a variety of means like scatter feeding, concealed feeding, providing multiple feeds, providing diets similar to that of free ranging conspecifics, etc.

a. Feeding Frequency:

The frequency of feeding at the enclosure often affects the welfare of animals in myriad ways. Feed frequency can be modulated by providing various feed enrichments such as concealed and scatter feeding across the paddock area to promote natural foraging patterns. Such enrichments can be beneficial for all taxa and can increase the daily time spent in foraging.

b. Feeding Locations:

Captive animals are almost always fed in the same area of the enclosure, which creates a high level of cognitive association of the animal with a particular location. When the animal is not allowed to access the feeding location, displacement behaviours are more likely to occur. Therefore by feeding the animals at different locations of the paddock area, a positive relationship with the entire enclosure environment is created

c. Rotation of Food Items:

In captivity, animals are often fed with the same diet, which creates a sense of monotony. Food choices for free-ranging animals are seasonally dependent and therefore bring in a diversity that is essential for the maintenance of species-specific traits. Rotating major food items in the diet of captive animals creates a novelty that can improve health and enhance cognitive skills through the effort required for processing complex food items. The rotation in food items is mostly relevant for herbivores, primates, Ursids, and small mammals.

d. Frozen Treats:

Frozen treats can be a special novelty for all type of animals, especially, Primates, Ursids, and Carnivores. These frozen treats incorporate the concept of contrafreeloading where animals are motivated to expend more time on getting food rewards with low nutritional value and promote species-typical behaviours.

e. Whole Food Items:

Free-ranging animals have evolved to forage on specific type of natural food materials. A significant portion of natural feeding behaviour consists of food processing and food handling. In captive conditions, animals are fed with preprocessed food items that do not require the expression of natural feeding behaviours. Providing natural food items will also increase the natural food processing behaviours and increase the time budget for foraging behaviours in captivity.

f. Feeding Log:

Hollow feeding logs can be placed at different locations of the enclosure to conceal food items and other enrichments. Most animals such as primates, ursids have a good repertoire of exploratory behaviours that they can utilize to extract food from the complex enrichment devices.

g. Honey Dispensers:

Honey is a natural and highly-sought after food resource for most wild animals such as ursids, however in the wild acquiring honey has a significant cost of bee-sting attached to it. In captive conditions we can increase species-typical behaviours by providing honey filled bamboo stumps on trees and other lessutilized areas of the enclosure and promote species-typical behaviour budget and space utilization patterns. The dispensers need to be strong, made of natural / natural looking materials and have a very small amount of honey inside so that the enrichments do not exceed the nutritional requirements of the animals. Such enrichments can be beneficial for primates, ursids, and small mammals.

h. Underground Food Pipes:

Animals like sloth bear need to meet behavioural requirements for foraging. The underground feeding pipes can be used to increase exploratory behaviours in animals.

i. Provision for Browse:

For ungulates browsing and grazing are primary requirements, by providing browse feeding opportunities in the enclosure, animals can be motivated to exercise species-typical behaviours that can improve welfare and competition for food resources in otherwise impoverished enclosure conditions. These enrichments can be used for herbivores and langurs.

Studies on Housing and Enclosure Enrichment of Some Species in Selected Indian Zoos- Wildlife Institute of India

Methodology for study of housing and & enclosure enrichment

1. Zoos were identified for the study based on the number of animals in enclosures and whether the animals were housed in appropriate social groups. Example: Solitary species, housed singly without any iso-sexual pairs and social species housed in groups.
2. A scoring sheet was developed based on existing guidelines and norms of animal husbandry and management. The scoring sheet was based on the principle of animal welfare and naturalism in enclosure design.
3. Essential aspects of enclosure were identified and scored.
4. Behavioural studies were conducted to measure the activity budget and enclosure space utilization pattern of captive animals.
5. Data gathered from behavioural evaluations was analysed to find how the animal welfare concerns were met in the paddock area.

a. Whether they were active
b. Whether they performed species-typical behaviours
c. Whether all areas of an enclosure was equally utilized
d. Whether there was conflict between group housed animals/ whether a solitary housed animal's welfare was compromised.

6. Based on the findings of the evaluation and behaviour study we identified shortcoming of each enclosure and designed an enrichment plan that could alleviate stressful situations for the animals housed in such impoverished enclosures.

7. The following document is a summary of our findings. In order to simplify and help disseminate the knowledge gained from the study, most scientific terminology has been rewritten in a simpler format.

8. The enrichment plan was designed to address the following concerns
    a. Species requirements in captivity
    b. Individual requirements based on behaviour patterns
    c. Time when enrichment is most needed based on activity budget
    d. Enclosure area that is least utilized based on space utilization pattern
    e. Areas of conflict with conspecifics

9. After implementing enrichment plans the behaviour of animals were recorded and modifications as required were integrated.

Animal Biology and Behavioural Ecology

Pheasant are birds that belong to several genera under the family Phasianidae in the order Galliformes. They are characterized by strong sexual dimorphism, males are highly ornate with bright colours and adornments.

Chapter 2

Pheasant: Essential Environmental Enrichments for Himalayan Monal

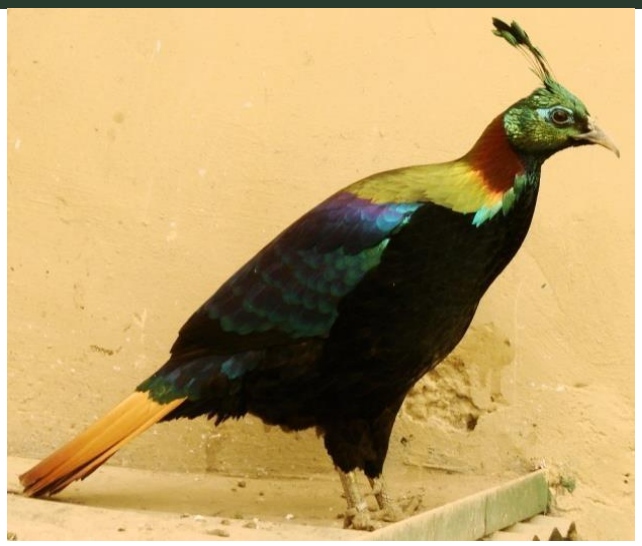


Plate 14: Male Himalayan Monal

Himalayan Monal is one of the three species under the genus *Lophophorus*, the other two being Sclater's Monal and Chinese Monal (*Lophophorus lhuysii* Hilaire 1866) which is distributed in northeastern hills of India and southeast China respectively. There is, so far, no confirmed record of subspecies in the Himalayan Monal. It is a relatively large-sized bird with reference to family Phasianidae. An adult male possess a long crest, are feathered with multi-coloured plumage throughout its body, while the females, like in other pheasants, are dull in colour with the upper parts covered with dark-brownish feathers. The Himalayan Monal secures a distinct position among pheasants due to its prominent built, brilliant plumage and strong association with local folklore. It occupies upper temperate oak-conifer forests interspersed with open grassy slopes, cliffs and alpine meadows between 24004500m, mostly concentrating in a narrow belt of 2700-3800m. They, however show tolerance to snow and have been observed to dig through snow for roots, tubers and other plant parts, and also invertebrates. Seen in pairs during the breeding season (April to August), they form large coveys and involve in communal roosting during the winter. Population of this species in most of its range is threatened due to poaching and other anthropogenic factors.

The birds have been observed singly or in parties of 3 or 4 consisting of a cock and two or three hens, or all of the same sex, which dig for food vigorously with their powerful bills on the edge of alpine pastures often in deep snow. A highly communicative bird, the Himalayan monal uses several different call types. Slightly less wary than other species and when flushed, rises with a loud flutter of wings, planing steeply downhill with wild ringing cries. When suddenly come upon in forest, especially if accompanied by

chicks, it flies up with much cackling into the thickly foliaged branches of a deodar or pine tree and freezes. The birds are somewhat gregarious, but the ties between flock members seem to be quite loose, and probably only during the winter, when the birds are forced into restricted habitats, are real flocks formed.

Monals feed on grass and flower seeds, roots, tubers, shoots, berries (e.g. *Cotoneaster microphylla*), and insects and their larvae, dug up often from under deep snow. They appear to forage throughout the day, using stout bill to search for insects and their larvae and tubers, as well as smaller quantities of seeds, shoots and berries, leaving characteristic patches of dug over soil up to 25cm deep. In autumn it is particularly seen to forage largely on insect larvae that it finds under decaying leaves. In summer feeds on alpine pastures and, in exceptional circumstances, within cultivated fields. The foraging behaviour of the monal is very distinctive, as they do very little digging with their feet, instead pick at the earth with their shovel like beaks. When a large tuft of grass or bamboo is encountered the birds will dig around it until it is left supported only by its bare roots, or it may actually be toppled over. The birds typically forage in small groups, but do not usually fight over foods that are excavated in this manner.

Table 1 Life history traits of Himalayan Monal

Call	*kur-lieu*, or *kleeh-wick*
Breeding Season	April- mid July
Nest Site/ Type	A scrape in the ground under shelter of a rock or a fallen tree-trunk in undergrowth on a steep hillside, hidden by grass or ferns.
Clutch Size	4-6
Eggs	Pale yellowish or reddish buff, freckled and spotted with reddish brown, Average size of 74 eggs 63.5×44.9 mm, and the esteemed fresh weight is 70.7g.
Incubation Period	Unknown; but seems to last some 26-29 days, usually 28 days
Attended by	Although there are a few suggestions in the literature that the male helps in caring for the young, but most authorities contend that he takes no part in the rearing phase.
Growth & Development of the Young	Not much information is available on this phase. Wayre in 1969 stated that in captivity the chicks are not difficult to rear on starter crumbs, to which has been added live food (maggots and mealworms) for the first few weeks.
Age of Maturity	Sexual maturity is attained at the second year of life. The immature
	males are reported to attain their adult plumage in the second year, before which they appear similar to adult females except for some small differences.

Mating System & Territoriality	This species is reported to be polygynous, a condition facilitated by the tendency of females to be gregarious. The pair bond lasts from mating to incubation. The high degree of sexual dimorphism suggests a polygynous mating system. Locations of individual males are apparently advertised by loud daily calling. The calling period in Himachal Pradesh seems to last from March through June. Gaston, Lelliott, and Ridley in 1982 suggested that although dispersion of males in spring gives some suggestion of territoriality, 14.5% of the males seen then were in groups of two, and 13% were parts of larger groups of birds (both sexes). Although aggressive behaviour between males was observed in May, these authors believed that strictly observed territorial boundaries did not seem to be present, and that loosely defined home ranges seemed to be a better description of dispersion characteristics. The highest densities occurred in areas close to precipitous crags, which probably provide both safe roosting sites and favourable launching sites for display flights.

Minimum Welfare Requirements of the Species in Captivity

Management in captivity requires the know-how of the species to be kept. As in case of Himalayan Monal, they are high altitude birds that dwell in area with good understorey. Hence, they should preferably be kept in high altitude zoos/pheasantry and should be provided with enough understory vegetation and perches in its enclosure.

There are 37 individuals in 8 zoos/ pheasantries across the country at present. In the zoos studied for this evaluation the birds were kept in pair or small group. The general observation made was that they were often treated like the poultry birds.

Findings from Enclosure Evaluation

The evaluation of Himalayan Monal enclosure was carried out in Sarahan Pheasantry, Sarahan, Himalayan Nature Park, Kufri and Padmaja Naidu Himalayan Zoological Park, Darjeeling. The following are the some of the findings -

1. Barren or monotonous exhibit area: Almost all the enclosure was barren with minimal enrichment items. Ground was compacted soil and often needed cleaning.

2. Ill-managed social groups: None of the enclosure had an ideal social grouping.
   Sarahan Pheasantry had only one male.

3. Predictable and routine way of food presentation: Feed is always given at the same location and at the same time in almost all the enclosure.

4. Limited activity: Pheasants were observed showing limited activity and were seen resting most of the time. Pacing was observed in almost all the birds.

Padmaja Naidu Himalayan Zoological Park Himalayan Monal Enclosure – Display and Off-display

The enclosures studied were situated in Darjeeling which has a somewhat similar geographical condition to monal's natural condition. Darjeeling has an average temperature that varies between 11°C to 19°C in summers and between 2.5°C to 10°C during winters. It lies at an elevation of 2050 m above sea level and receives an average rainfall of 3200 mm annually.

The display enclosure was 32.26 m^2 in area with a roof at a height of about 10 m and was a part of a bigger aviary. It housed two individuals 1:1 and was situated at the extreme end of the PHNZP zoo.

Plate 15: Display enclosure for Himalayan Monal

Plate 16: Off-display enclosure for Himalayan Monal display enclosure.

Enrichment Options

Before getting to the enrichment part of the paddock, a few pointers that need to be considered for the viewing area are:

- The approach to the enclosure should have enough vegetation to camouflage or hide the aviary.
- Taller and proper vegetation need to be encouraged between enclosure and visitors' barrier.
- Measures such as increasing the height of the stand-off barrier to a level that limits visitors from leaning or climbing over it.

The Off-display enclosure was much larger in size measuring an area of about 95 m^2 with a roof height ranging from 3-5 m. It housed two individuals 1:1 and was the only aviary around. Enrichment devices and furniture were present in a larger number in this enclosure compared to

- The wire mesh roof of the enclosure could be covered with plastic after appropriate camouflaging.

i) Habitat Enrichment:

Since the pheasants have to stay enclosed their entire life some variation in their habitat environment is essential to bring novelty in their daily life. Himalayan monals live among coniferous and mixed forests with welldeveloped bamboo, rhododendron and other under-storey scrub. They are also usually found in the meadows and forest clearings on steep Himalayan slopes. Mimicking the natural condition of this species is not easy however not impossible and presence of species specific vegetation is the most important step towards achieving it.

In order to provide a natural environment in an enclosure the following steps could be taken –

a. **Substrate** – Natural substrates are encouraged with proper vegetation growth. The ground of the enclosure need to be loosened periodically and a portion of the ground could be used for keeping sandy soil for dust bathing and digging since monals are strong diggers and sandy soil provides a good medium. However, care need to be taken to provide proper airing and sunlight required to keep the soil dry.

b. **Terrain** – Flat terrain in any enclosure could be modified by introducing earthen mound or big boulder to give some undulation and steep cliff like feel.

c. **Vegetation** - Small size bamboo species and other plant species that give proper under-storey need to be introduced. Grasses can also be introduced if they could be grown on the ground. Since the size of the enclosure is limited there cannot be much planting inside.

d. **Perches** – Monal likes to roost or rest on elevated places such as on trees or shrubs. Therefore, there should be perches at different heights and sizes inside the enclosure. Wooden logs/tree branches can be used to create elevated platforms and pathways. Bamboos can also be used as perch.

Perches should be free of sharp edges and size that can be readily gripped by the claws but large enough that the bird's toenails do not damage its footpad. Material of the perch should provide a firm grip to the birds and be cleaned easily.

e. **Visual Barrier** – Ideally vegetation could be used to create barriers between adjacent enclosures and along one of the viewers' areas however, growing vegetation takes time. Use of bamboo/straw/grass mat could be effective immediately. Care needs to be taken to make sure that barrier is only half the height of the wall so that the sunlight still reaches inside the enclosure.

f. **Nesting/Roosting** - Monal scrapes a nest in the ground in the wild. Therefore, provision should be made to allow the female to scrape a nest by providing area secluded from the public and leaving enough material (grasses, straw, husk, twigs, etc.) to build a nest. Ideally brush and bushes are required to be used as hideouts/withdrawal area and also to build nests on the ground. However, till the time new vegetation grows, grass or straw could be used to build a secluded place for the pheasants.

g. **Enrichment Devices -** Feeders could be designed in such a way that it looks more naturalistic than the plastic and tin feeders used inside the enclosure. Custom made wooden feeders could be used such as in plate 17. Heavy earthen pot or hole on an elevated ground could be used for water.

Plate 17: Artificial feeder

- Straw bales can be used to provide elevated surface, and since they are a substrate suitable for foraging, provide a surface to peck at scattered feed.

ii) Feeding & Foraging Enrichment

The monals were fed once a day in the morning which consists of grains mixed with green leafy vegetables. The feed was enough to last for the day. The female started feeding immediately whereas the male remained perch on his spot on top. Some enrichment methods that could be adopted are as follows -

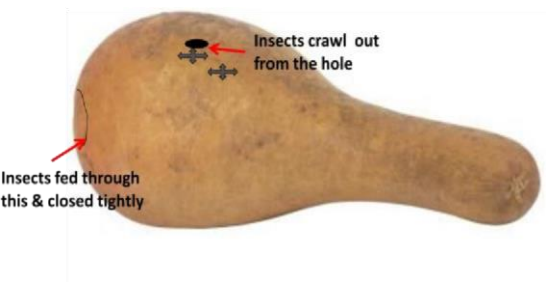


Plate 18: Gourd feeder

a. Feed

- Feeding enrichment such as feed scattering could break monotony and increase the activity of the pheasant.
- Live insects like termites, crickets and earthworms can be introduced since monals are naturally omnivorous and this diet would meet the protein requirement of the birds.
- Introduction of dried paddy would stimulate pecking and foraging behaviour of the pheasants.
- Changes in the feeding regime and providing novel food such as ear of maize, whole cabbage, freshwater snails, slugs, etc. once every week or so.

b. Feeding Device

- Log feeders: Food stuffed into drilled holes in the side of logs. These logs could be hung across the corner/ edge of the enclosure or on slightly elevated structures.
- Gourd feeder: Holes drilled in gourd filled with crickets or such other palatable insects.
- Leafy vegetables could be planted on trays/wooden boxes to feed the pheasants.
- Seeds and tubers, etc. can be buried inside the loosened soil for the birds to dig and feed. This would encourage the pheasants to spend more time foraging.

With the help of the techniques mentioned above, it might be possible to give a more natural foraging experience to the animals despite being held in captivity.

iii) Sensory Enrichment:

The enrichment activities involving scents, sights and sound are all sensory type enrichment which is also essential to add variety to the animals enclosed in an unchanging captive environment. Enriching dominant sense of the species using harmless, non-stressful stimuli could benefit animal welfare (Wells 2009). Pheasants have excellent vision, acute hearing and keen sensitivity to vibration. Therefore, in this case, enrichment involving auditory and tactile stimulation should

be focused to encourage sensory responses. The followings are few more ways of how sensory enrichment could be incorporated inside the enclosure.

- Play sounds replicating those of the animals' natural habitat or its several different calls.
- Presence of a place for dust bath. Sandy soil should be provided in some area of the enclosure.

iv) Social Enrichment:

Wellbeing of the birds in captivity also depends on the social grouping and association with their conspecifics. Himalayan monals have been observed singly or in parties of 3-4 consisting of a cock and two-three hens. In the studied enclosure there were only two individuals that hardly interacted during the observation period. However, late in the afternoon the male flew down and showed courtship behaviour for a brief period.

- Since monals are more likely to be in a group than alone especially females, number of individuals in the enclosure could be increased. This might help reduce pacing behaviour of the female inside the enclosure.
- Monals are highly vocal so if possible conspecies enclosure could be made nearby where they could communicate.
- Feeding enrichment could encourage the individuals to forage together on the ground.

Summary

Duration of the study, difference in season and enclosure limited the study result. However, certain positive changes could be observed in the more enriched off-display enclosure. The following points briefly sum up our observations during the study:

1. Provision of enough space and enrichments could reduce aberrant behaviour to some extent.
2. Proper study duration and planning is required to bring forth a conclusive result for enrichments.
3. Enrichment devices and strategies need to be presented on a varied schedule and in a variety of contexts to make sure the pheasants do not become desensitized or habituated to them.

4. Presence of enough enthusiastic animal care staff is essential for a successful enrichment plan since they are the one who has to look after the enclosure and continue taking care of the animals.

5. No enrichment plan or design is perfect or fixed for specific species and there should always be a scope of improving or improvising it. There has to be a constant change and innovation.

Some Enrichment Introduced inside the Off-display Enclosure

Plate 19: Provision of feed and water inside the off-display enclosure. Same kind of water feeder and feed were provided however there was no separate cell to keep them

Plate 20: Furniture and enrichments inside the off-display enclosure

Primates: Essential Environmental Enrichments for Lion-Tailed Macaques

Chapter 3

Plate 21: Adult male Lion-tailed macaque at Mysore Zoo

Description

Lion-tailed Macaques are completely black in colour; a distinct grey/Silver white 'mane' frames the face of the monkey. The mane surrounds the head and goes down the chin. The Lion-tailed Macaques have a long tail with a distinct black tuft at the end, hence the name. It is a group-living arboreal non-human primate endemic to the Western Ghats of India.

Table 2 Morphometry of Lion-tailed macaque

Crown-rump length	54.4cm (Males), 46.5cm (Females)
Rump-heel length	41.9cm (Males), 34.1cm (Females)
Weight	5.6-12.8 Kg (Males), 3.9-8.3 Kg (Females)
Tail Length	Average 35cm (Males), average 27 cm (Females)

(as reported by Harvey and others in 1991)

Habitat

Vegetation and Cover: The Lion-tailed macaque prefers to live in broad-leafed evergreen forests found in the Western Ghats of India. The LTMs are well adapted to the rain forest ecosystem and are known to raid coffee plantations in the region.

Terrain: Despite being a predominantly arboreal species, they frequently come down to the ground to drink water or forage. The LTMs roost in the trees at night.

Special Niche: The Lion-tailed macaque is considered one of the most important habitat specialist primates of India. These primates are exclusively restricted to the evergreen forests of the South Indian states of Kerala, Karnataka and Tamil Nadu.

Home Range and Territory: Daily movement varies from 650m-2km. There is high seasonal variation in the movement patterns of the LTM throughout their range.

Movement Pattern: the lion tailed macaque is an arboreal animal moving from one tree to the other by jumping. Although the animal can show quadrupedal locomotion, it is a last resort when the forest cover is sparse.

Spatio-Temporal Activity Patterns: The LTMs are diurnal in nature. Behaviour peaks are observed early in the morning 0530-0630hrs with interspersed travelling involved. After the major bout of feeding is over the group disperses. The group takes rest from 1200-1400 hrs. This was the time when social interactions are at the highest. Afterwards the LTMs searched for food (mostly invertebrates). There is another major feeding bout at 1600-1700 hours, when the group gathers at a large food tree. The activity dies down by 1800-1830 hours, when the group settles in a clump of trees close to the major feeding tree.

Area of Choice for Nest/Den: The LTMs like to roost on trees at night.

Vegetation Utilization: The LTMs forage for fruits, flowers and insects on trees.

Feeding Ecology

Foraging Strategy: The Lion-tailed macaques are omnivores but fruits constitute a significant portion of their diet; it can also survive on leaves, seeds, insects etc. The free-ranging Lion-tailed macaques spend significant portion of the daytime foraging (23.7%) and ranging (34%). In wilderness they are known to forage for algae and fungi as well. Flower, buds, young leaves etc. form a significant portion of the diet. The Liontailed macaques have cheek pouches the size of their stomach which makes it easier for them to gather the food and then eat it at leisure.

Water: A typical LTM troop does not stray far away from the nearest water source

Feeding Regime: As mentioned earlier, the Lion-tailed macaque spends about 44.25% of their daily activity budget on foraging. The food primarily consists of floral (77.78%) as well as faunal (22.22%). It has been seen that the group members keep their distances while foraging and come together only during resting periods. The diet composition of the Lion-tailed macaque vastly depends on the season. For example fruits are the food of choice during monsoon, while flowers are consumed more frequently after monsoon is over.

Daily Time Budget/ Activity Pattern of LTM

In-situ studies done on a feral group of LTM living in a disturbed fragment of habitat of 0.65 km^2 show that the LTM group members spent most of their time ranging (34%), followed by foraging (23.7%), feeding (17.9%), resting (16.0%) and social interactions were at the lowest (8.4%). The monthly variations of all the other activities are significantly higher than that of ranging. Resting and foraging activities are negatively correlated. When key food species like *Cullenia* is absent (September-November) there was a marked increase in foraging activity. The animals spent 40.4% of time at canopy levels between 21-30m. Groups in disturbed habitats spend more time in quadrupedal locomotion than those living in protected forests.

Social Structure

Group Size: The Lion-tailed macaques show typical philopatry in case of females. The average group size in the wild is 13.17 individuals. The group size of the Lion-tailed macaque depends on the resource richness in the area. The number of animals in a LTM group living in a resource-rich area will be higher than those living in an area lacking quality food resources.

Table 3 Group composition of Lion-tailed macaque in the wild

Age/sex	Mean No	Median no	Range	%comp
Adult males	1.5	1.0	1-3	9
Sub-adult males	1.4	1.0	0-5	8
Adult females	7.3	6.3	3-14	41.5
Immature	8.0	8.0	1-21	41.5

Group Composition: It has been found that the adult male to female ratio in Liontailed macaque groups is 1:2.11 while that for the adult to young ratio is 1:0.84.

Social System: The females in the Lion-tailed macaque community stay with their natal groups upon reaching maturity while the males move out. So there is a constant immigration and emigration of adult males in a typical Lion-tailed macaque group. It has been seen that the females prefer to mate with immigrant males than the resident ones. So it goes without saying that the arrival of a new male within a group is likely to result in a lot of aggression among males.

Social Hierarchy: The lion-tailed macaques have a multi-male multi-female social system and the entire group is built upon a very intricate social fabric. The LTM society follows a typical matrilineal hierarchy. The animals often live in forest areas with home ranges overlapping with other Lion-tailed macaque groups.

Communication: The Lion-tailed macaques are known to have as many as 17 different vocalizations, which are coupled with body movements to communicate with other group members. The Lion-tailed macaques also use visual communication via facial expressions to communicate with the group members. The fear grimace expression is shown when the lips are retracted and the animal shows its clenched teeth to the animal towards which the behaviour is directed, this behaviour is usually used to reduce aggression.

The Lion-tailed macaques have a prominent threat expression with which the animal stares right at the recipient individual with an open mouth.

Grooming: The grooming behaviour is a way to strengthen social bonds among primates. In LTMs grooming behaviour is predominantly observed among the females and the infants. The females also groom other females and dominant males.

Agonistic Behaviour: LTMs often live in forest fragment with home ranges overlapping with other groups. If a LTM group invades the territory of another the males of each group start showing agonistic behaviour.

Sun Basking: Like all other primates LTMs also need to be in the sun during some parts of the day. Sun basking is important because it aids Calcium absorption in bones among the primates. Regular exposure to sunlight synchronizes the biological clock and helps maintain physiological homeostasis.

Reproduction

Mating System: Polygynous

Age at First Birth: The females become sexually active by the age of 5 years and the males mature at eight there is no specific breeding season for the *M. silenus,* the females' show perineal swelling when they are in estrus. Females might reproduce at the age of 48 months in captivity according to the females reach sexual maturity at 65.2 months.

Mate Selection: There is serious competition among females for breeding rights so mate selection is female biased. In a matrilineal hierarchy, there is a serious risk of inbreeding if there is no mate selection.

Table 4 Life history traits of Lion-tailed macaque

Breeding Season	Infants are born nearly throughout the year, a marked birth peak occurs in January–April.
Litter Size	1
Life Span	20 years(wild), 38 years (Captivity),
Estrous Cycle	40.55 days
Gestation Period	24 weeks
Rearing of Young	Mother and other females of the group rear the young one.
Growth & Development of the Young	The infants are effectively weaned only during the second year during the period of resource abundance. The average survivorship rate of an infant in the wild is about 0.87.
Inter-birth Interval	The mean inter-birth interval is estimated to be 34.3 months.
Age at first reproduction	females 65 months
Mating System	Polygynous

Role of Dominance Hierarchy: The dominant male gets to breed with the females in the group.

Mating Behaviour: Female at the follicular phase of the estrus cycle shows a perineal swelling that signals her sexual status. The female also vocalizes to attract potential mates. There are two types of mating calls. Once the mating pair is formed they separate from the rest of the group to copulate. The group members (especially the females) often harass the pair.

Staccato call: The females made this call 83.6% of time before mounting during the swelling period.

Proceptive Call: The female made this call throughout the swelling period irrespective of swelling.

Parental Care: The mother is heavily invested in parental care. The other female group members might help in raising the infant. The males never take part in rearing the infant.

Minimum Welfare Requirements of the Species in Captivity Findings from Literature Review Findings from Enclosure Evaluation

During the course of our study we visited zoos from all over the country and evaluated primate enclosures housing different species. We identified the challenges common to most primate housing facilities, these are summarized below.

1. **Social Grouping:** In most zoos, we found that some animals were singlyhoused and this is contraindicated for every primate species. While some primates live in single male multiple female groups, others live in multi-male, multi-female groups. Some other primates like Gibbons live in pairs. Therefore, a careful understanding

of the social requirements of a certain primate species is important to provide adequate welfare in captivity.

2. Vegetation: Most often than not primate enclosures lack species-typical vegetation that is required for the expression of natural behaviour repertoire.
The common problems with vegetation in primate enclosures are as follows

a. Vegetation does not have the appropriate stratification for the animals

b. Vegetation (trees) does not have appropriate branching for animals to move.

c. Although some enclosures do have a good number of trees but the arboreal perches are not interconnected and therefore do not provide the same amount of mobility. The perches at all primate enclosures should be interconnected at more than two points so that animals may lead a primarily arboreal lifestyle.

3. **Food Presentation**: Primates are very intelligent and spend a significant amount of time acquiring food from nature. In captivity animals are provided with pre-processed food that takes little or no effort to acquire, this impedes the animal's ability to use its mental faculties to the fullest. Usually zoos provide food to animals at fixed time and inside the retiring cell. The animals consume the food within a short amount of time and have no other activity left to do for the rest of the day.

4. **Enclosure Space Utilization**: Due to the lack of enclosure complexity, we often find that primates stay localized at certain areas of the enclosure and avoid rest of the areas. Optimal enclosure space utilization means that the
animals are exploring their captive environment and are not afraid of any areas. Homogenous enclosure space utilization pattern is an indicator of better welfare and should be one of the simplest ways to assess the psychopathological condition of the captive animals.

5. **Activity Budget**: Every species has a set pattern of behaviours they show in the wild. These behaviours help the animals find food, socialize and procreate. An animal that cannot display its species-typical behaviours in captivity is not a good representative of its wild counterparts. Therefore such animals are unfit for reintroduction in the wild and cannot help disseminate appropriate knowledge about the species to people. Therefore we need to create a captive environment that encourages animals to display these species-typical behaviours and help them lead a more fulfilling life.

6. **Positive Relationship with the Paddock Area:** Usually animals are provided with food inside the retiring cells and that creates a positive relationship with the night shelters. On the other hand, animals are usually highly stressed at the

paddock area due to continuous visitor disturbance. We found that animals preferred to stay near the retiring cell area or the back-section of the paddock area most of the time because they expect food and shelter from that place. If we want the animals to feel good about their captive environment, we should provide food and shelter in the paddock area and create a positive relationship with the area.

7. **Retiring Cells/Night Shelters:** Most of the night shelters are not designed to house social animals. The night shelters for primates in most Indian zoos lack the required facilities to house a social animal in appropriate welfare.
Following features should be included in resting cells

a. The resting cells should be big enough to house the entire primate group. There should be a provision to separate a few individuals of the group for treatment/transportation when required.

b. The resting cells should have interconnected arboreal perches for the animals. The perches should be big enough to accommodate 3-5 individuals so that they may roost together.

c. The retiring cell should have manipulable enrichments at multiple locations that the animals can use to play and socialize. Providing food enrichments can lead to increased chances of conflict in close quarters and should be avoided at all costs. If feed has to be provided in the retiring cell, dominant individuals should be lured into a separate cell with food and then the subordinate individuals should be fed.

d. The retiring cell should have secured skylights that allow sunlight.

Plate 22: Open wet moated enclosure for Lion tailed macaque at Arignar Anna Zoological Park

e. The retiring cell should be well ventilated to keep the area dry and free of germs. Conclusions from enclosure assessments

Summary of Enclosure Evaluation for LTM island wet-moated enclosure at Arignar Anna Zoological Park

Visitor Viewing Area

The visitor viewing area for the LTM enclosure is continuous and covers more than 80% of the enclosure area. Therefore visitors have access to the animals from almost all sides apart from the retiring cell area. The enclosure design also lends itself to cross viewing and therefore the viewing area needs to be modified as it fails to provide the animals with adequate visual barriers.

Plate 23: Continuous viewing gallery at AAZP

Plate 24: LTM foraging and drinking impure moat water

The wetmoated design also poses certain health risks to the primates, as animals were often found drinking moat water. The enclosure is small for a group of eight lion-tailed macaques and the area should be increased so that subordinate animals may have the optimum flight distance from dominant individuals.

Enrichment Devices

Paddock Area Characteristics

The enclosure has a wet-moated barrier, which is hard to maintain and wastes water.

The enrichment devices inside the enclosure included natural vegetation and some rope bridges that were not functional anymore. The enrichments were mostly manipulable and did not provide any food rewards to the animals.

stratified and provides a decent amount of cover. The canopy is interconnected that creates arboreal pathways and promotes an arboreal lifestyle.

Plate 25 Zookeeper preparing food at retiring cells

are the last ones to feed.

Vegetation Features

The enclosure at AAZP is mostly covered by vegetation that allows Lion-tailed macaques the chance to lead an arboreal lifestyle. The vegetation is moderately

Retiring Area

The enclosure has a very small retiring cubicle that is used to provide food to the animals. Since there is only one entrance to the retiring cell, the stronger animal Ravi monopolizes food resources. Older animals such as Rani and Mohan

Socio-Ecology and Behaviour

The LTM enclosure at AAZP housed eight macaques in a single enclosure. Over the years, this group had turned into a coherent unit where all animals were living harmoniously.

Plate 26: Mohan sitting away from the group

We found that the animals spent a large proportion of the daily activity budget on the ground, which is unusual since LTMs are primarily known as an arboreal primate species. This goes on to show that LTMs housed in the AAZP enclosure do not have equal opportunities to display an arboreal lifestyle like their wild counterparts.

Behaviour Response to Existing Enclosure Regime

Behaviour studies were conducted at The LTM enclosure of Arignar Anna Zoological Park, to understand the daily activity patterns of the housed animals. The animals at the island moated enclosure were studied using focal animal sampling method and *ad libitum* sampling as established by Altmann in 1974. Enclosure Space Utilization study was also done by dividing the enclosure into different zones and noting the proportion of time spent in that area by the LTM group. Finally, the amount of time spent on different substrates of the enclosure was also measured.

Plate 27: LTMs at AAZP grooming

Inferences

1. In captivity, the animals spend more time resting than in the wild.

2. The captive LTMs showed less foraging and ranging behaviour than their wild counterparts did. Thus there should be some feeding enrichments in the enclosure

3. In wild, the LTMs spend most of their time on the canopy but in captivity LTMs mostly move around in the ground.

4. The enclosure space utilization study showed that the animals were not using the proximal zone of the enclosure as much as the median and distal zone.

5. Utilization of the proximal zone significantly diminished as the number of visitors increased.

Table 5 Evaluation of existing enrichment at Lion-tailed macaque enclosure

Animal Requirements	Existing enrichment	Observation	Enrichment required
Arboreal pathways	Interconnected canopy is vital for LTMs to maintain a arboreal lifestyle	The animals do not have the opportunity to perform distinct instinctive behaviours under captive conditions.	Upright logs with smaller logs creating interconnection with each should be constructed.
Promotion of natural activity budget	Animals are habituated to most of the enrichments inside the enclosure and therefore fail to elicit natural activity budgets		Enrichments that promote foraging behaviours should be implemented to increase the amount of time spent by animals on speciestypical behaviours.
Promotion of enclosure space utilization	Enrichment items are localized at the distal end of the enclosure. Animals have no incentive to explore other zones of paddock area	The LTMs show a highly biased enclosure space utilization pattern.	All under-utilized enclosure zones should be provided with enrichment items that enhance usage

Enrichment options for lion-Tailed Macaque

Enrichment plan can be divided into two broad categories

A. Social Enrichment: The LTMs will be enriched if they are kept in social groups.

B. Inanimate Enrichment: Enrichment devices that require physical activity from the animal (active enrichment) and enrichments that provide passive stimulation only. This distinction is arbitrary as the passive enrichment can be converted to active forms and vice versa depending on the usage patterns of the animal.

A. Social Enrichment: LTMs live socially in the wild. Although group sizes may vary depending on the resource availability, LTMs are rarely seen alone therefore, it is essential to keep the captive LTMs in constants social contact with conspecifics. Primates spend a significant portion of their daily timebudget interacting with other members of the social group. The communication between group members can vary from brief “location calls” to prolonged communication with extensive physical contact. Interactions might include both affiliative as well as aggressive behaviour. It is important for the primates to have positive relationships with their conspecifics as well as the zoo keepers as this might reduce the stress associated with husbandry and management tasks (Reinhardt, 1997). Social enrichment also includes training the primates to cooperate with husbandry, veterinary and research procedures, thereby reducing stress caused by sedatives and anesthesia.
Primates should never be singly-housed.

- In some cases social stimulation is the most effective type of enrichment as it stimulates all the sensory systems of the animal.
- Social stimulation is the only form of enrichment which does not run the risk of producing habituation among the animals.
- Housing primates like LTM in social groups facilitates the expression of species-specific behaviour. Some of the most common social behaviours include grooming, play, copulation and nursing.
- Social interaction is the most dynamic and complex form of enrichment.
- Reinhardt has performed a number of experiments on the iso-sexual pairing in macaque species.

- Contrary to popular belief it has been discovered that incompatible behaviour usually results from unequal food sharing rather than aggressive behaviour.
- The unidirectional dominance system can be used to assess compatibility between the macaques.
- Some studies have also found that the adult iso-sexual pairing and adult-infant pairing in primates can lead to reduced self-aggression among previously singly-housed animals. The groupings were between adult male-infant, adult female-infant and adult female and male pairs.

1. **Management of Introduction:** Certain protocols need to be followed when new animals are being introduced into an existing social group of captive LTMs. The procedures have been outlined by McNary in 1992.
   a. Allowing the new animals, time to explore and become familiar with any new area in the absence of unfamiliar conspecifics.
   b. Allowing the LTMs to have visual access to each other (e.g., through plexi-glass barriers, adjacent holding areas).
   c. Allowing the LTMs tactile access to each other.
   d. Allowing the LTMs Physical access to each other.

2. **Group Formation:** The final objective of introducing a new animal is to assimilate it with the existing social group. Group formation can be achieved in the following ways.
   a. The objective is to assimilate the singly housed individuals into a group without an increase in aggression levels.
   b. Absence of aggression related problems has been reported in both mixedsex group formation in both juveniles and sub-adult rhesus macaques.
   c. The introduction of two adult males in a rhesus macaque group was aggression free and also reduced the amount of stereotypy displayed by both the animals.

B. Inanimate Enrichment 1. Food Enrichment

a. **Contrafreeloading:** The term contrafreeloading was coined by the animal psychologist Glen Jensen. Contrafreeloading food resources means to

make the animals work for their food. Providing the animals with half coconut shell filled with mashed fruits (like banana). There should be enough coconut shells for all the animals (Stephanie Tomoser, Pueblo Zoological Gardens, Brown Lemurs, Zoo Zen Volume 2). The animals should be presented with foods that have high processing time (e.g., corn on the cob and sugarcane, they will increase the foraging time of the animals by good -measure.

b. **Arboreal foraging:** Creation of arboreal pathways throughout the enclosure, with extensive branching promotes locomotion. A portion of the daily food ration can be placed at variable heights in different trees. The fruits can be cut into small pieces, packed in nylon net bags and suspended from multiple points. The holes in the net should not allow the animals to take out the food with relative ease (Samantha Stephens, Auckland Zoo, Siamangs, Zoo Zen).
c. **Food Distribution:** Instead of giving the food ration at a pre-defined place each day, it can be distributed at different points of the enclosure. This will increase foraging time and increase the rate of food acquisition among all age/sex classes.

d. **Unpredictable feeding regime:** Studies on captive Chimpanzees revealed that stereotypy and inactive behaviours can be reduced significantly if the nonhuman primates are fed according to a dynamic feeding schedule.

e. **Foraging Boards:** These devices are attached to the side of the cage and consist of a tray or board on which a substrate (e.g. artificial fleece or artificial turf) is fixed. The animal must search through the substrate to find the concealed and desirable food items. These foraging boards have been successfully tested on singly-housed baboons, singly-housed rhesus macaques and they have significantly reduced selfdirected and cage-directed stereotypic behaviour among the animals.

f. Puzzle feeders: The puzzle feeders present a cognitive and manipulative challenge to animals generally involving the manipulative challenge to animals. The puzzle feeders for nonhuman primates vary in design and complexity. The primary objective of a puzzle feeder is to increase the foraging time by increasing the processing time for feed. The puzzle feeders have been tested on chimpanzees, long-tailed macaques, rhesus macaques, Stump-tailed macaques, Pig-tailed macaques, Baboons etc. Although the increase in foraging time is not consistent across all Primate groups but it is quite obvious that the increase in foraging time leads to less aggressive behaviour and stereotypic behaviour. Other benefits include reduction in inactivity and the provision for cognitive stimulation. However, one should keep in mind that having a single puzzle feeder might increase aggression among inmates, so there should be multiple devices positioned at different areas of the enclosure.

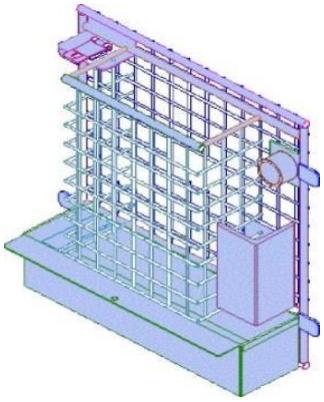


Plate 28: Foraging boards

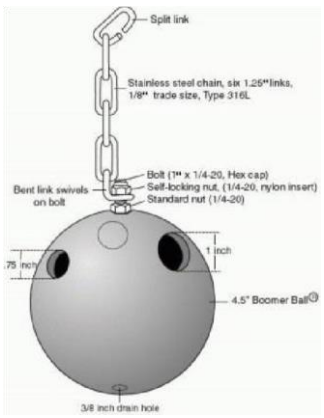


Plate 29: Puzzle feeder

Salient features for Enrichment of LTM Enclosure

- There should be a number of sources of variation in the type of enrichment devices used by the animals.
- Intragroup aggression, species-identity, sex, age, experience, motivation, behaviour disorder, dominance status etc. are important considerations that should be made before implementing enrichment devices.

- Feeding enrichment if rightly applied is a valuable tool for adjusting behavioural abnormalities in primates.
- Optimal effects can be received by increasing the variety of enrichment devices in a rotational program.

2. Physical Enrichment: Not all enrichment devices are associated with feeding. Primates are naturally curious animals; they explore and manipulate different type of objects in the natural environment. Having some toys and portable objects can be provided to the captive primates to give them certain opportunities for manipulation and exploration. However studies indicate that simple toys do not alter the behaviours of aged rhesus macaques. This goes on to show that the enrichment devices need to be targeted towards the animal's needs. "Toy preference" is an important concern, on an average females manipulate and handle objects more than male primates. The usage patterns may vary depending on the type of manipulable object and the sex differences in toy preference. According to Young (2003; p.143), 'the enrichment devices should be both species-specific as well as goal-specific'.

It was found that adding novel objects to those already present in the cage increased the manipulation time by the chimpanzees from 8% (0 novel objects) to 54% of time (10 novel objects). It has been observed that the number of days to decline to a usage level below 15% took longer for 10 novel objects (7days) than that for a single object (3days).

It has been observed that captive chimpanzees manipulated destructible toys 27% of the available time compared to non-destructible toys (10% of the time).

The amount of toy use is very low in singly housed primates but increases considerably for socially housed subjects. The interest in manipulanda is at its highest on the first day and dies down gradually. Toy usage is highest when the toys are rotated and when there are a large number of toys within the enclosure.

- **Swings:** Swings can be made from ropes and light-weight logs with holes drilled on the sides.
- **Perches:** Perches help the animals get a good view of the surroundings and acts as stimuli in itself. Perches add a vertical component to the enclosure and stimulate arboreal behaviour among

primates. The presence of perches at different strategic locations of the enclosure enhances the spatial memory. For the captive arboreal primates like LTM perches that replicate some of the key functional features of a forest habitat can encourage locomotor, perceptual and cognitive behaviour.

- **Ropes:** Hanging ropes from the trees can create arboreal pathways for the LTM. However the ropes should be made of natural fibres and should not pose a choking risk for the animals. The ropes should be tied at both ends so that no free ends pose the risk of trapping or strangulating animals. Ideally vines, and creepers should be allowed to grow inside the enclosure

- **Visual Barriers:** Visual barriers can help reduce agonistic behaviour by providing an opportunity for a threatened animal to hide from the aggressor. Visual barriers have been found to reduce aggression and increase affiliation in rhesus macaques and pig-tailed macaques. Levels of aggression can be lowered with visual barriers at the preliminary stages of group formation in captivity.

- **Water Baths:** Shallow water troughs placed within the enclosure are known to encourage tool-use and food-processing in captive primates. Water troughs play an important role in inducing species-specific play behaviour among the primates.

- **Manipulable Objects:** The manipulable objects may help in reducing inactivity and abnormal behaviour among LTMs and replace them with desirable species-specific behaviours. Branches and sticks are good examples of natural manipulable objects. If space is not a limiting factor, an uprooted tree can be placed in the enclosure. Use of branches and sticks has been known to reduce self-directed behaviour in singly-housed primates.

Important Considerations:

- Providing structures that enable complete utilization of the enclosure's vertical component is highly desirable in a LTM enclosure.

- Climbable furniture could be fixed/ moveable or rigid/flexible.
- Dominant individual tend to occupy higher vantage points, so there should be distinct stratification for all individuals in the social order.

- Perches can significantly reduce intragroup aggression among primates.
- Manipulable objects should be such that they cannot be incorporated into routines of self-harm and as targets of threat and aggression.
- Practical and safety issues should take first priority while the manipulable objects are incorporated into the enclosure.
- The manipulable objects might block the drainage system of the enclosure.
- If ingested the manipulable objects might pose a health risk to the animal.
- The animals might become possessive about their enrichment items and get stressed at their removal. So care should be taken while rotating enrichment devices.

C. Sensory Enrichment: Sensory enrichment focuses on stimulating animals' senses. Primates like LTM rely heavily on their senses to survive in wild.

Audio-visual stimulation is a very important part of enrichment.

- **Visual Enrichment:** Visual enrichment can be accomplished by placing a Television or a mirror next to the enclosure.
- **Music:** White noise played in the enclosure can enhance the cognitive abilities of the housed primates

Table 6 Enrichment options for Lion-tailed macaque

Enrichment Device	Enrichment type	Materials required	Location	Species-typical behaviour targeted
Separate entry point to the enclosure	Permanent fixture, sensory enrichment	Height 2m and width 1.5m. The door will be placed above the moat near retiring cell and entry into the enclosure will be through a retractable ladder, which will reduce wear and tear on the door	The separate entry point will help zoo keepers enter and exit the enclosure with enrichment items and food for the animals	Easier to implement enrichments with a separate entry point.

Perches	Manipulable and feeding enrichment	Four logs will be placed adjacent to each other, and tied so that the primates can climb on it. Holes can be drilled on to the logs and filled with small treats like raisins. The logs should be more than 4m tall above the ground and an additional 1.5m under the ground.		The animals can scratch against the logs, climb on them to search for food, The exploratory nature of primates can be encouraged through these upright logs
coconuts	Manipulable and feeding enrichment	Small coconuts (green and ripe) will be hung from branches so that the animals have to manipulate the items to get to the tasty endosperm.		Promotes exploratory behaviour, play behaviour etc.
Feeding Schedule and Area	Management Practices	We have observed that the animals do not use the paddock area after feed was given at 1530 hours. We strongly recommend that the food be provided at the paddock area and not in the retiring cells. The food should consist of natural unprocessed food products found in the natural habitat of the target specie (liontailed macaque)	Food can be provided at the medial portion of the enclosure	Promotes enclosure utilization. Helps animals display more speciestypical behaviours.
Bamboo stumps	Feeding and sensory enrichment	3-4 upright bamboo stumps with fruits inside them can be used to provide small food treats (like grapes). Holes in the stumps will be used to load the treats and the animals need to use their fingers to get them.	The bamboo stumps can be placed at the proximal and median zone	Promotes enclosure utilization. Helps animals display more speciestypical behaviours foraging

Testing Efficacy of Enrichment Devices

Enrichment devices setup and findings

Plate 30: Ball feeder

Ball feeders	Feeding enrichment	Whole fruits increasing the processing time. Furthermore, keeping these food items inside nets and small boxes necessitates that the primates interact with the devices and use their dexterity to get to the food reward	These food boxes can be placed on top of trees, hanging from branches etc.	Promotes species-typical foraging behaviours

Ball Feeders Construction

The ball feeders were made from two cane baskets, placed one on top of the other and stitched with jute ropes. Holes were made at the bottom basket on all four sides. A strong jute rope was attached to the top basket so that the entire contraption could hang from a tree branch. A stick was positioned through the contraption to provide a foothold for the primates to get to the food. The ball feeders would be filled with food items such

as Bengal grams, grapes, and seasonal fruits.

Plate 31: Cane baskets required to make ball feeder

Materials Required

1. Two baskets made from cane
2. Ropes made from strong jute fibre
3. PVC pipes of diameter 7-8 inches

Plate 32: Attach cane baskets from inside

Method

1. Take two baskets and a pass a strong rope through the base of each basket so that you get some loose rope between the baskets.
2. Attach the loose ropes so that the baskets are very close to each other

Six such hanging ball feeders were constructed and placed inside the enclosure. While some ball feeders were placed at a height of 1.5m from the ground, some other were placed barely 0.75m from the ground. The ball feeders were spaced far from each other to ensure that no animal monopolized all the food resources at any given point of time.

Every morning, the keeper would come in and fill up each of the six hanging balls with fruits. All the ball feeders were filled up in the first few days with the same mix of food. We found that some of the animals had distinct food preferences. By providing small amounts of all food types at each ball, we increased the food processing time of each individual.

We found that the ball feeder was the most frequently used enrichment device among the lion-tailed macaques. Previously all food was provided inside the retiring cell on the ground, which did not require the animals to process the food in any way. These ball feeders also increased the amount of cooperation as LTMs started utilizing these devices in pairs, with one animal taking out food and throwing it on the ground and the other animal (sitting on the ground)reserving a share for the first one.

Plate 33: Bamboo feeders

Bamboo Feeders

The bamboo feeders were fashioned from hollow bamboo stumps. Holes were made inside these stumps so that food could be placed inside these stumps. These bamboo feeders were tied close to the main trunk of the tree so the macaques had to spend a lot of time getting the small grapes and Bengal grams out of the crevices. These feeders were replaced with preloaded bamboo feeders by the keeper every alternate day. By replacing the bamboo feeders, keepers could clean them and prepare the next batch of feeders without spending too much time inside the enclosure. We found that the keeper required an average of 15±5 minutes to load all enrichment devices with food when assisted by two labourers.

Construction

In order to make a complex bamboo feeder for primates, we need a bamboo stump, saw, drill, hammer, and ropes. The steps involved in making this device are described below.

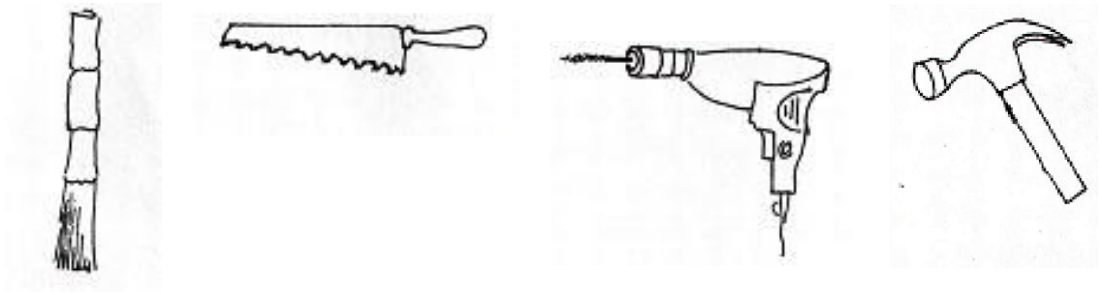
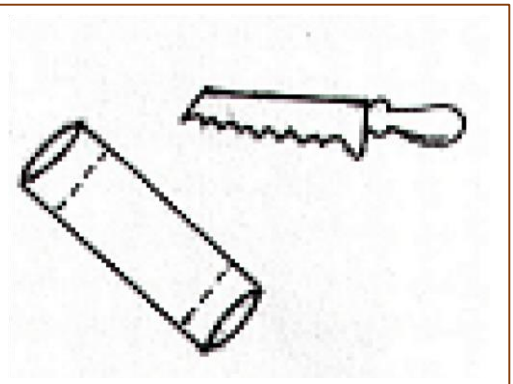


Plate 34: Bamboo stump, hand saw, electric drill, and hammer



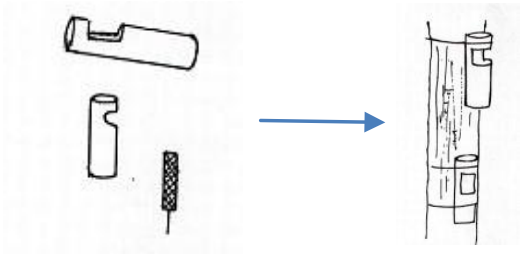


Plate 35: Cut the bamboo stump in sizeable pieces, and then make a rounded hole at the top, file it before attaching to the tree

The first step involves cutting the bamboo shoot at the nodes, in a manner so that we get a hollow tube closed on both sides. Then we can use the saw to cut along the dotted lines to create grooves on the sides of the bamboo stump. These grooves will help attach the stump tightly against the tree.

In the following step, the bamboo needs to be cut in manner so that there is a rounded hole in the upper section. The hole needs to be big enough so that animals may put their hands inside the bamboo feeder, but should not fit the entire arm. The edges of the hole should be smoothened to reduce chances of skin lacerations while using enrichment devices.

Hanging Coconuts

The hanging coconuts were of two types: the first type was ripe coconuts with holes drilled in them and hung from a small branch. The Second type was simply

a complete green coconut that was hung from the tree. These novel enrichment devices were made by passing a needle with a string through a coconut. The loose end of the string was hung from a small branch. The LTMs were found to enjoy these treats quite a lot and frequently visited the sites containing these enrichment devices. The presence of these enrichment devices above the ground also helped the macaques lead an arboreal lifestyle.

Plate 36: Hanging coconuts used as enrichment devices

Findings

We found that the hanging coconuts were very successful in encouraging cognitive skills of the primates. The dominant male used his strength to open the green coconut and was engrossed with it for a long time, which afforded more time to other macaques to forage on enrichment devices without being harassed. After fulfilling their nutritional needs, the coconuts became toys for the sub adults and elicited a number of social behaviours that were previously unseen at the enclosure.

Manipulable Enrichments with Hanging Coconuts

Manipulable enrichments or ‘Manipulanda’ form an important part of enclosure enrichment programs. There were four poles of steel present inside the enclosure that were not used by the macaques. We placed branches on top of these four posts to make a platform that could serve as a perch from where the animals could have a **Findings**

It was found that the combination of manipulable enrichment structures with feeding and sensory enrichments was important to create a positive association with the artificial structures. Once the animals received food rewards by using manipulable devices, they started using them more. The playful behaviour exhibited by animals around manipulable devices increased to such a degree that the animals later started using manipulable devices even in the absence of food rewards.

vantage point and survey the surrounding area. We also added small fruits and coconuts dangling from these branches

Plate 37: Vantage point with hanging coconuts

Swings and Bridges

We also provided certain swings to the animals that could be used to move from one branch to the next. These swings were made from upside down baskets hung from trees. The swings were very effective in eliciting species appropriate behaviour responses from the macaque. These enrichment items were designed with the safety of animals in mind, we placed knots at fixed length of all rope so that the individual strands stayed together for a longer amount of time. Adequate precautions were taken.

Plate 38: Swings used as enrichment devices

Findings

The swings and bridges provided LTMs with a chance to lead an arboreal lifestyle. The bridges and swings allowed animals to move through the canopy without having to come down on the ground. The animals preferred to stay on arboreal perches and were found, socializing, grooming and playing on these arboreal pathways. Although the enclosure had some trees, it lacked interconnectivity, which was established through the implementation of swings and bridges. The

amount of change in social behaviour of the LTMs and the performance of these social behaviours at the site of enrichment interventions indicate an increase in animal welfare conditions for the animals.

Table 7 Efficacy of enrichment intervention in Lion-tailed macaque enclosure

Pre – enrichment feature	Modified enclosure feature	Needs addressed	Efficacy of enrichment post enrichment study
Lack of novelty in the enclosure environment.	New enrichment devices implemented.	Boredom and lack of opportunity to perform instinctive behaviour mitigated.	The animals started showing diverse behaviour repertoire.
Proximal and medial zones underutilized.	All enclosure zones were provided with feeding and sensory enrichments.	The animals could now forage and move through the enclosure in search for treats.	The daily movement of the animals increased. All enclosure zones equally utilized.
Animals show a high preference for distal areas.	Enrichments were placed at distal, median and the proximal zone.	Animals had to move through all parts of the enclosure to use enrichment devices.	These enrichment devices reduced food monopolizations by dominant male LTMs. Increased cooperative foraging behaviours, where two individuals used the enrichment devices to get maximum rewards.
Arboreal LTMs were spending more time on the ground than on perches.	Feeding and sensory enrichments were placed on perches. Furthermore, the trees were connected via rope bridges and swings, which the animals used to travel through the canopy.	Although the enclosure had a good amount of stratification. The ground strata was more enriched than the arboreal areas. Postenrichment, complexity of all enclosure zones increased, therefore animals could exercise their choice and they shifted to a arboreal lifestyle.	The LTMs spent more time on perches than on ground.

Recommendations

The recommendations based on the findings of the enrichment intervention are summarized below.

1. Enrichments and scientific management practices effectively reduce aberrant behaviours and promote social behaviours such as play and grooming. Animals performing these socially appetitive behaviours are naturally in a better state of welfare.

2. Food is the biggest motivation for the study subjects and therefore all enrichments were designed based on a reward-based positive reinforcement approach to make the animals spend more energy to get miniscule food rewards. The complexity of each enrichment item was increased to make the task of acquiring food rewards more challenging and time consuming, which maintained the novelty of enrichment devices.

3. It is recommended to change the locations of certain preferred food items across the enclosure. This would ensure that the animals had to visit all the possible foraging sites in order to get their choice of food items. By placing foraging boxes, feeding balls, bamboo feeders etc. far apart from each other, we ensured that the dominant individuals never had the opportunity to monopolize food resources.

4. At each of the foraging boxes, it is desirable to place a mix of foods with high processing time and low processing time. This will ensure that the animals could not move through all the enrichment items very fast. The complexity of the food items forced animals to spend significant amount of time on each enrichment artefact.

5. It was realized that enrichments need to be individual-centric and should also look at the status quo between conspecifics. Enrichment interventions should not lead to undue stress and aggression between conspecifics. For example, while a dominant LTM male was feeding from a ball feeder, a subordinate individual could scavenge food that was accidentally dropped by the animals

6. The enrichment interventions in Lion tailed macaque enclosure at Arignar Anna Zoological Park is proof that any enclosure enrichment intervention has to be at the individual level, since social animals are more likely to get stressed when they cannot derive benefits from enrichment devices. The personality of the animal concerned and the location of the enclosure should be taken into consideration before drawing up enrichment plans.

7. Problem identification is a very important step that should precede every enrichment intervention.

Plate 39 : Indian Wild Dog (Dhole) at Indira Gandhi Zoological Park, Vishakhapatnam

Animal Biology and Behavioural Ecology

Habitat & Ecology:

Canids- Essential Environmental Enrichments for Indian Wild Dog, Dhole

Chapter 4

The Dhole is found in a variety of habitat types like primary, secondary and degraded forms of tropical dry and moist deciduous forests, evergreen and semi-evergreen forests, dry-thorn forests, scrublands etc. In India, as these habitats support a larger prey base.

Table 8 Life history traits of Dhole

Age at First Reproduction	1-1.5 years
Estrous Cycle	14-39 days
Litter Size	4-6 pups. Pups are born blind, eyes open between the 13th and 15th day
Gestation period	60-63 days
Weaning Age	31 days
Inter-birth Interval	NA
Lifespan	15-16 years
Mating Season	In India mating occurs between September and January. Captive dholes in Moscow Zoo breed in February.

Behaviour and Social Organization:

Dholes are group living animals with a bi-level social organization. The “pack” acts as the hunting and the feeding unit and the pack members stay together all the time. Sometimes two or more packs might come together to form “clans”. The clan assembly primarily revolves around social interactions during rest and play periods. Not much is known about the degree of genetic relatedness in clan or pack members. Loners are a rare occurrence in the Dhole communities. The size of the pack varies between 3-28 adult members.

Dhole packs hunt separately but all of them might assemble after the hunts to share the kill. Clans can contain as many as 40 adults at any point of time. During the end of the monsoon or at the beginning of the denning season, the dholes are most frequently seen in small groups. Although there is no clear evidence of dominance hierarchies in the Dhole pack, in the free-ranging pack an adult male is often clearly dominant over the other pack members. Aggression among pack members is virtually non-existent and there is little or no competition at kills.

Captive dholes are known to urine-mark one another. Dholes practice site-specific defecation so certain areas within their territory acts as communal latrines (Cohen, Fox, Johnsingh, & Barnett, 1978). The play behaviour involves soliciting play with lower forequarters, wagging tail and engaging in chase and ambush games. All members of the pack play with each other during certain times of the day, which helps cement the bond between pack members.

Vocal Communication:

Vocal communication plays a huge role in Dhole social behaviour. Dholes show a high amount of social activity in both wild and captivity. Dholes are known to yap, whistle, bark, howl, squeal, scream, whine, squeak and yap-squeak to the members of the pack as well as to intruders. It is believed that in the absence of

visual or olfactory stimuli, long-distance biphonation calls may provide cues of individuality to pack members.

Food and Feeding Behaviour

Dholes like to feed on Chital (*Axis axis*) and it forms the primary prey base. Large packs of Dholes have also been observed killing Sambar, wild pigs, Muntjacs, and mouse deer. In Tibet and Ladakh the Dholes are known to hunt wild sheep, antelope, Markhor, musk deer and Ghorals. Livestock comprises a very small proportion of Dhole diet. Dholes have been seen killing Panthers, Bears and tigers. Dholes also hunt rodents, hares, palm squirrels, field rats during the dry season. Some other dietary items include birds, lizards, insects and vegetation like grass, leaves, fruits etc. In South India an analysis of 150 Dhole scats revealed that the most commonly represented prey species was the common hare (*Lepus nigricollis)*, which was closely followed by Chital, Sambar, field rat and wild pig. The average weight of prey killed by Dhole packs in Panna Tiger Reserve was 55.3 kg.

Dholes are carnivores and they are among the most ferocious hunters in the wild. Dholes hunt in packs and a pack of Dholes can bring down prey 10 times their size with their extraordinary hunting skills. Dholes chase down and exhaust their prey and then attack them from all sides. The prey usually dies of shock and blood loss.

The Dholes primarily like to hunt during dawn or right before twilight. The pack remains inactive during midday (especially during summer). The Dhole packs might hunt on a moonlit night there is no aggression at the kill and all members of the pack eat harmoniously. Juveniles are given preference at the kill.

Reproductive Behaviour

Unlike most other canid species, mating is not confined to any season and can occur any time of the year. There is no dominant breeding pair and all the pack members can mate however, in some packs there are dominant breeding pairs who produce offspring although several females come into heat. At the Schwerin Zoo in Germany, the highest ranking female hindered the subordinate female from mating with the dominant male. In a wild dog pack at the Dresden Zoo, the dominant male tried to hinder subordinate males from copulating with the dominant female. In captivity pups stand a high chance of being eaten by other adult pack members. Births usually occur late at night or during the early hours of morning.

Pup-rearing is a social activity and all the members of the pack take part in it. Dholes can mate any time from September to January. The gestation period lasts

between 6063 days. In India the pups are most often born during the months of January and
February. The average litter size is around 4-5; the maximum number is 9-10. Offspring of two or more females may live in the same den. Female dholes are known to den and rear their offspring together. A number of females select a den site and together form a breeding colony.

Certain members of the pack act as “guards” and stay back with the pups, while the rest of the pack is out hunting. At about 70-80 days age the pups leave the denning area and at the age of 7-8 months they actively participate in prey killing. The Dhole pups reared in captivity show agonistic behaviour towards each other till 7-8 months of age, after that the dominance hierarchy is established. The pack members are highly tolerant of each other at kills and there is very low level of competition for access to kills. Both adults and pups indulge in playful behaviour.

Minimum welfare requirements of the species in captivity Findings from literature review

Minimum AZA Guidelines for Keeping Medium and Large Canids in Captivity

Canids are mostly cursorial animals that have strong social bonds, including exclusive male/female pairing during the breeding season. The bonding between canids can often extend through the pup-rearing period. In captivity the animals are often singlyhoused which often results in the onset of aberrant behaviours.

Some aspects of captive management for all Canids have been discussed below:

Temperature: Dholes are not tolerant to extreme variations of temperature. Animals kept outside should have access to shade, especially during warmer parts of the year. Zoos located in cold areas should provide wooden pallets and space heaters for the animals.

Lighting: Natural lighting is optimal for dholes. When needed, fluorescent lighting can be used for full-spectrum illumination.

Water: Fresh clean water for drinking should be available at all times. Watering devices should consist of either built-in devices or sturdy portable container. Regardless of size, water containers should be cleaned and disinfected daily. Some canids enjoy bathing and swimming, and pools should be incorporated into outdoor enclosures.

Sanitation: Hard-surface, pallets, and food containers (if used) should be cleaned daily with detergents. Dirt substrates in outdoor exhibits should be raked and spot cleaned daily. Foot baths should be used prior to entering and exiting all canid enclosures or area containing enclosures. Each should be filled with a disinfectant and its use strictly adhered to by all personnel.

Enclosure Dimensions: Enclosure sizes vary according to species and social group. As a general rule, a single large canid should have enclosure measuring at least 3.1mx4.6m or 14$m^{2.}$ For each additional animal, the enclosure size should be increased by 50%. A medium canid should be housed in a 2.5m x 4.7m enclosure

Barriers: Perimeter barriers should be at least 2.5m high and include an inward facing overhang, the top protected by electric cable or a 45 degree overhang. In addition to vertical barriers, all perimeters should also have either a concrete footing or a horizontal protective mat around the entire enclosure. Most median and large sized canids are prolific diggers and can easily tunnel under a chain-link fence. Where feasible, enclosures should be designed without square corners.

Food: Medium and large canids are easily maintained when fed commercially or custom-made diets. Commercial preparations containing all necessary vitamin and mineral are readily available, or may also be custom-made by the holding institution. On a daily basis, canids require 1-3kg of high quality, low-fat diet per 25kg of body weight. Whole animals used as feed should be limited to freshly killed carcasses, and should be removed at regular intervals. Diets containing high percentages of fowl, especially ones containing chicken or turkey necks, should be avoided due to inadequate levels of calcium and phosphorus.

The quantity of rations fed will also depend on individual condition and whether or not feeding is communal or done on an individual basis. Where communal feeding is practiced, weights of subordinate animals and juveniles must be closely monitored. Obesity also occurs where communal feeding is practiced, and fasting all members once a day in a week may be used for weight control. Milk substitutes used to hand rear infants should be specifically formulated for canids. Milk replacers should contain low levels of lactose to prevent eye problems.

Veterinary Care: Services of an experienced veterinarian should be available to all holders of non-domestic canids. When circumstances permit, an overall examination should be performed annually, blood samples collected, serum blanked as a baseline control, and the results recorded. Faecal examinations should be made twice a year to check for parasite infection and should be screened monthly during their first six months. Routine deworming with a broad spectrum anti-helminthic at six and eight months of age is highly recommended. Preventative heartworm medication should be given to all canids housed in areas where this parasite is prevalent, and an occult heartworm test performed annually.

Findings from Enclosure Evaluation

Arignar Anna Zoological Park:

The wild dog enclosure at Chennai zoo housed 3 females. The enclosure was dry moated open-air with wall and chain link mesh acting as the standoff barrier. The enclosure was previously constructed for housing jackals and it is presently being used to house wild dogs. The enclosure had open access to the animals from all sides, the visitors could also access the retiring cells of the enclosure.

Plate 40: Wild dog enclosure at AAZP, Chennai

Enclosure Evaluation 1. Public Utility Area

Public utility area is one of the most important aspects of enclosure design as it creates the platform for interaction between the animal and visitors.

Plate 41: Public utility area of Dhole Enclosure

a. **Visitor Viewing Area:** Visitor viewing area is an important part of any enclosure as it determines the level of access the visitors have to the enclosure and the animals housed in them.

b. **Visitor Access:** The standoff barrier at the AAZP, Chennai is not very effective. The visitors have unrestricted access to the distal zone at the zoo.

c. **Enclosure Barrier:** The enclosure barrier was safe, did not have rusty parts and posed no risk of injury to the animals housed.

d. **Visitor Barrier:** At the AAZP dhole enclosure, a wall with a wire mesh barrier was the only standoff barrier.

e. **Enclosure Visibility:** The visibility at the enclosure in all three zoos was very high. Cross-viewing should be minimized while designing a carnivore enclosure and this aspect was ignored at all the zoos**.**

2. Enclosure Characteristics

a. **Enclosure Barrier:** The enclosure was open-air dry moated type and provided freedom of movement to the animals.

b. **Enclosure Topography:** Every enclosure should have an undulating terrain in order to provide the animal's sufficient areas for withdrawal from visitors and conspecifics. The enclosure was mostly plain and provided very few withdrawal areas.

c. **Substrate type:** Natural substrate was present throughout the entire enclosure.

d. **Shelter:** Every enclosure should have shelters so that the animals can stay safe from the inclement of weather and thermoregulate. The enclosure had provision for natural shelters like bamboo clumps.

e. **Withdrawal Areas:** Withdrawal areas are vital to the welfare of captive animals as they allow animals get away from the stress imposed by enclosure mates and zoo visitors. The enclosure had a lot of vegetation but unrestricted visitor access reduced the number of effective withdrawal areas.

f. **Enclosure Space Utilization:** The level of enclosure space utilization is highly emphasized in literature; however, how the space is utilized is also important.
The space utilization was minimal and the animals are stressed by visitors.

g. **Enclosure Aspect:** The enclosure had dense vegetation cover and provided a lot of shade to the animals; however, the high vegetation density restricted airflow.

h. **Irrigation:** Every enclosure should be well irrigated to encourage growth of vegetation inside the enclosure and be well drained to prevent water logging.
The studied enclosure was well irrigated.

i. **Area of Activity:** Wild dogs are cursorial animals that walk and run long distances to hunt, the enclosure should accordingly have adequate space to support such activities. The enclosure; however, allowed visitors access from all sides to the enclosure, thereby restricting the area available for animal activity.

3. Furniture and Enrichment Devices

Enclosures should have furniture and enrichments that encourages species-appropriate behaviour and create a naturalistic environment for the captive animals. All furniture and enrichment devices in an enclosure should be made of substrate the animal might encounter in the wild.

Plate 42: Water pool the most used feature of the enclosure

a. **Species Appropriate Furnishing:** The enclosure had minimal furnishing; however, a water pool was provided where the animals could drink and bathe.

b. **Species Appropriate Enrichment:** Species appropriate vegetation was provided and the animals showed a certain degree of natural behaviour.

c. **Types of Enrichment:** Only manipulable enrichment was provided to the animals.

d. **Safety of Enrichment:** Enrichment devices provided at the enclosures did not pose any risk to the animals.

e. **Enrichment Device Usage:** Enrichment devices that are not utilized by the animals serve no practical purpose. All the enrichment devices provided were used and natural features within the enclosure were also utilized.

f. **Enrichment Device Material:** All enrichment devices were made of artificial substances and need to be modified to introduce more natural elements within the enclosure.

g. **Enrichment device location and effectiveness:** Enrichment devices need to be placed at appropriate positions of the enclosure to increase their utilization.

4. Vegetation

Vegetation features of an enclosure helps create an immersive effect and provide a natural ambience for the animal. Every enclosure should have a good mix of trees, and shrubs as they create a novelty in the captive environment. However care must be taken before introducing any new vegetation inside an existing enclosure as it may affect the animal adversely.

Plate 43: Dholes resting under vegetation

a. **Species Appropriate Vegetation:** The vegetation in the enclosure was species-specific and offered adequate amount of sun and shade to the animals.

b. **Vegetation Density:** Vegetation cover determines the extent of shade available in an enclosure. Vegetation density was very high restricting airflow in the enclosure, that lead to high humidity and chances of disease outbreak.

c. **Vegetation Usage:** The vegetation at Dhole enclosure was mostly used for shade and thermoregulation during the hot afternoons.

b. **Stratification:** Vegetation density and stratification are closely linked. The vegetation stratification of an enclosure is vital to the well-

5. Retiring Area

Captive animals in zoos spend most of their time inside retiring cells. The retiring cells therefore should be developed to meet the needs of each captive species. Dholes are social animals and need to be socially housed. The retiring areas need to be big along with ample vertical space as Dholes are good jumpers. The floors of the retiring cells should be natural and soft to protect the animals from foot injuries.

being of an animal. The enclosure had well stratified vegetation that was effectively utilized by the animals.

Plate 44: Retiring cells and day kraal for dholes

a. **Grouping:** Being social animals dholes need to be housed together in a retiring area with access to off-display outdoor kraals. The enclosure had individual retiring cells and animals were separated inside the retiring cells.

b. **Ventilation:** The retiring cells should have a good air circulation so that there is no residual humidity and air flow is maintained. A constant draft of air reduces chances of moisture accumulating in different areas of the retiring cells and inhibits growth of pathogens. The retiring area was well ventilated and had unhindered air-flow.

c. **Sanitation:** Sanitation conditions were sub-par in the retiring cells.

d. **Illumination:** No natural or artificial lighting was available in the retiring cells for dholes.

e. **Furniture:** The furniture at the retiring cells was minimal and should be changed to suit the species-specific requirements. The retiring cells had cemented flooring which is not advised for dholes as they like to jump and might break their legs while landing on a hard floor

f. Enrichment: Enrichments were non-existent and should be increased in the retiring cells to increase the living conditions of the animals.

Plate 45: Wild dogs interacting

g. Day Kraal: A kraal having soft soil as substrate was present, however it had a low wire mesh ceiling that limits vertical animal movement.

6. Socio-Ecology and Behaviour The behavioural response of the animals to their captive environment was assessed and the observation for the same are presented here.

a. Social Grouping: Proper social grouping of captive animals ensures natural behaviour among captive animals. The enclosure housed a pack with inappropriate sex ratio.

7. Nutrition

Nutrition is a vital component that determines captive animal welfare. The diet mostly consisted of chicken meat and the animals wasted a lot of food every day.

Behaviour Response to Existing Housing and Enrichment Program

Activity Budget

In the initial part of the study, we found that the dholes in the AAZP dry-moated enclosure spent most of the daily activity budget in stereotypic behaviour (45%). The animals spent a greater part of the forenoon and afternoon, resting in the retiring cell area (32%) and occasionally they would visit the small water pool on the distal right hand side of the enclosure, take a dip and come back to the original position to rest again. The other behaviours such as walking feeding (chewing left over bones) formed an insignificant part in the daily time budget.

Space Utilization Pattern

We found that under the existing enclosure housing and enrichment practice regime the animals spend all of their time in the distal portion of the enclosure (near the retiring cell). From 1100-1500 hours the animals mostly rested in the area by lying down and sitting. During the rest of the day the animals performed movement stereotypies such as pacing. The animals never approached the proximal area of the enclosure and rarely came close to the median zone.

Summary of Enclosure Assessments

To surmise the findings from enclosure evaluations,

1. The public utility area was continuous and created stress.
2. The animals were released in the paddock area in pairs, which was one of the primary causes of stress and stereotypic behaviour.
3. The animals were given food in the retiring cells.
4. The water-pool provided enrichment in the paddock area and promoted some species typical behaviours.
5. Social grouping in the enclosure was not appropriate.
6. The dholes performed more stereotypy near the distal area and the retiring cells.
7. Food was presented in an unappealing manner in the retiring cells and was often wasted by the animals.
8. Vegetation was dense in some parts of the enclosure, restricting airflow and enhancing humidity that led to further discomfort for the animals.

Enrichment Planning based on Existing Review of Literature

Table 9 Enrichment options for Dholes

Enrichment Device	Enrichment Type	Materials Required	Location	Species-typical behaviour targeted
Visitor gallery	Permanent fixture, sensory enrichment	The visitor viewing area at Chennai zoo dhole enclosure should be reduced so that the animals have some space for withdrawal from visitor disturbance	Visitor access should be restricted to proximal zone	Reducing visitor access will provide animals with more withdrawal space
Pitfall feeder	Feeding enrichment, manipulable enrichment	1ft pvc pipe of diameter of 10 inches placed at different zones of the exhibit and loaded with enrichment items like small chunks of meat	At the proximal and median zone of the exhibit	Foraging and exploratory behaviour

Group formation	Social Enrichment	Right now only two adult dholes (1:1) are released in the enclosure. We believe that dholes should be maintained in social groups. Therefore, pups should also be released with the adults to create a more cohesive group		Social behaviour, species-typical behaviour patterns
Branch piles	Manipulable and feeding enrichment	Small logs 20-30 of them of length 3ft and diameter 8 inches can be used to make piles at different locations and loaded with small pieces of meat and bones	Median and proximal	Promotes exploratory behaviour, play behaviour etc.
Scratching posts	Manipulable and sensory enrichment	Single upright logs with rough bark will help the animals autogroom themselves by rubbing their back on the logs	Median zone	Promotes autogrooming and other behaviours such as scratching etc.
Feeding Schedule and Area	Management Practices	We recommend that the food be provided in the paddock area and not in the retiring cells. The food should consist of natural unprocessed food products found	Food can be provided at the median portion of	Promotes enclosure utilization. Helps animals display more species-

Plate 46: Enrichment device setup

Testing Efficacy of Enrichment Devices

Enrichmer Device	Enrichmer Type	Materials Required	Location	Species typical behaviour targeted
		in the natural habitat of the target animals.	the exhibit	typical behaviours.

Enrichment Devices Setup and Findings

The AAZP dhole enclosure was modified with some naturalistic enrichment interventions that were designed to promote species typical behaviours. A summary of the enrichment devices, their construction, and effects on animals is discussed below

Earthen Mounds

Earth mounds perform various functions for dholes. In a humid environment such as Chennai the animals can remove ectoparasites by rolling in the dirt. The dirt mound also serves as visual barrier and animals can hide from visitors. Moreover, these dirt mounds also provide the animals an opportunity to burrow during whelping and rearing pups.

Plate 47: Earth mounds

Findings

We found that the animals frequently dipped themselves in the water pool and rolled over in the dirt mounds. This was probably a mechanism for thermoregulation, this was a novel behaviour that was not previously seen

in the unenriched enclosure. Dirt mounds therefore are effective enrichment devices.

Pitfall Feeders

Pitfall feeders were made from PVC pipes dug underground with only one end emerging out, the

bottom of each was filled with coarse gravel and pebbles. We placed dressed chicken breasts inside each of the six pitfall feeders placed inside the enclosure. The pitfall feeders were distributed across the proximal and median zones of the enclosure.

Plate 48: Pitfall feeder with dressed chicken

Findings

Although the animals showed some curiosity towards the feeders, they stayed away from the food for the major part of the post-enrichment study. This pitfall feeder is an inefficient design as exposing the raw meat to humid conditions, draws maggots and the meat putrefied within a span of few hours. This enrichment device did not yield success and was discontinued from the first day onwards.

Water Pool

A water pool was already present inside the enclosure and was working. We found that the animals preferred using the water pool for drinking as well as thermoregulation.

Plate 49: Water pool for Dholes

Findings

We recommend such water pools for all dhole enclosures. The water pool served as a place for socialization and play behaviour amongst the pups and adults.

Scratching Posts

The scratching posts were created to enable the animals to groom themselves. Coir ropes were bound tightly to form an abrasive and irregular surface on the otherwise smooth bark of the trees. The dholes had a lot of ticks on their faces and other inaccessible areas of the body. These scratching posts were designed to provide animals with an opportunity to remove ticks by rubbing themselves against the tree.

Plate 50: Scratching posts

Findings

We found that the dholes were curious about the coir ropes and tried to take them apart with their teeth a number of times. On the first day of study, the animals had not made the association between the ropes and autogrooming. From the next day onwards the usage of scratch posts increased by a large margin as the animals started to rub against them.

Blockades

We found that the animals at the AAZP dhole enclosure were performing stereotypic behaviours like repetitive pacing near the retiring cell along a fixed path. In order to mitigate these aberrant behaviours we placed thorny branch piles on the trails created by the animals.

Plate 51: Blockades

The motive behind this action was to coax animals to utilize other enclosure zones that were under-utilized due to the stereotypic behaviours.

Findings

This roadblock for dholes worked very well and reduced the occurrence of stereotypy by a large extent; however, this was a negative reinforcement technique and should be coupled with positive associations with other underutilized portions of the enclosure. When used in conjunction with positive enrichment interventions like social enrichment and feeding enrichment, the animals may stop performing stereotypy. However, if only roadblocks are made and the animals are not provided with any other avenue to vent their stress, it can lead to further welfare concerns. Such road blocks should be used only as a last resort.

Visual Barrier

We placed visual barriers in an attempt to stop the adult dholes from communicating with the pups.

Plate 2: Visual barriers

Findings

We found that the barrier did not stop communication as the animals switched to vocalizations. Moreover, the presence of visual barriers agitated the animals and they started tearing down the agro net with their teeth. Therefore, we removed all visual barriers from the enclosure and released all pups inside the enclosure with the adults.

Post Enrichment Behaviour Evaluation

The post enrichment behaviour evaluation was done in two parts

1. With visual barriers + blockades + enrichment items- pups kept inside retiring cells
2. No visual barriers and blockade + enrichment items+ pups released with adults

In the first scenario we found that although the animals did not perform any stereotypic behaviour due to the presence of blockades, they were upset due to the visual barriers.
The animals vocalized and rested near the retiring cells and showed no interest in other enrichment items.

In the second scenario, we removed all visual barriers and blockades, we also released all the pups inside the enclosure with the adults (parents). This led to a remarkable change in the behaviour pattern. The animals started socializing and play behaviours and with display of stereotypic behaviour ending completely. However the animals never used the proximal and median zones of the enclosure and enrichments placed in those zones remained grossly under-utilized.

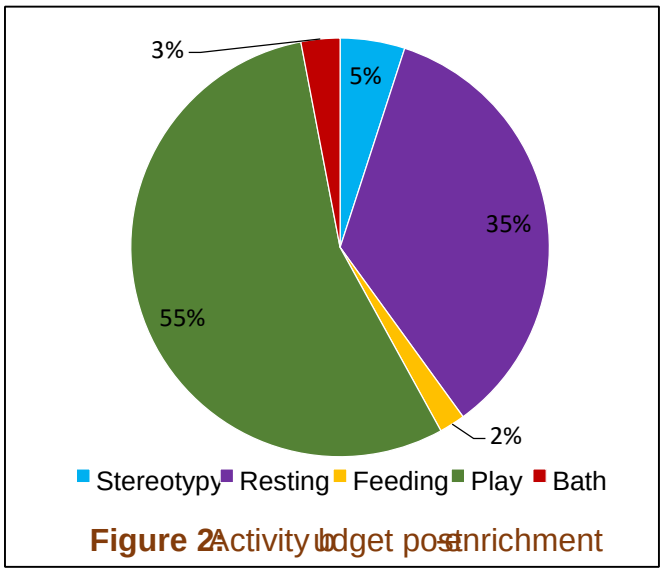


Figure 2 Activity budget post enrichment

Activity Budget

We found that after releasing the pups along with adults in the paddock area, the level of stereotypic behaviour dropped significantly. The amount of play behaviour significantly increased (55%). The resting times however remained almost unchanged (35%). Other behaviours such as bathing and chewing bones were also largely unaffected. We concluded that the animals spent most of their time socializing with conspecifics and this therefore is the most important enrichment.

Space Utilization Pattern

We found that despite enrichment interventions, the animals chose to stay near the distal zone of the enclosure and never ventured into the proximal end during the study period. Therefore, we feel that the visitor gallery should be redesigned to provide a

windowed viewing opportunity for visitors to ensure that animals are not unduly stressed by visitor presence.

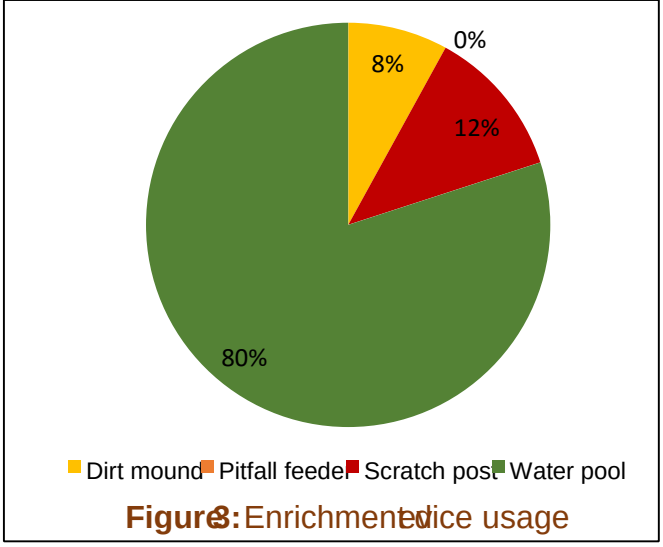


Figure 3: Enrichment device usage

Enrichment Device Usage

We found that the most frequently used enrichment item was the water pool. The study was done in the period during October-November 2013 and the animals still preferred to use the water pool for thermoregulation due to the high ongoing temperatures in Chennai. The pitfall feeder was the least used enrichment item. The second most frequently used enrichment item was the scratch posts and it was closely followed by the dirt mounds (8%).

Table 10 Efficacy of enrichment intervention in dhole enclosure

	Enrichment Types	Species-typical behaviour targeted	Observation	Remarks
1.	**Feeding Enrichment**			
	Pitfall feeders with chicken	We expected the animals to forage on the chicken pieces readily	The animals were not very enthusiastic about the pitfall feeder with chicken meat	Alternate feeding methods should be explored.
2.	**Sensory Enrichment**			
	Water pool	The water pool was supposed to be used by the animals occasionally to quench thirst or to thermoregulate	The animals spent most of their time near the water pool, bathing, drinking and playing with one another	There should be one water pool in the medial portion of every enclosure
	Scratching post	The animals were supposed to autogroom at the scratching posts to take care of ectoparasites	The animals occasionally used the scratching posts	The scratching posts were mostly used for grooming. Two such posts are sufficient for each enclosure
	Earth mounds	Earth mounds were provided to promote allogrooming and digging opportunities for the animals.	The animals used this sensory enrichment extensively. After each bath the	Fresh earthen mounds should be created in an enclosure every month. These mounds should be created in unique locations

			dholes would roll around in the dirt	
3.	**Social enrichment**	We released the pups with their parents to see whether there were any agonistic interactions or not and the affiliative behaviours displayed by the animals	The pups started playing and running around the enclosure as soon as they were released. The parents stopped the stereotypic behaviour and started playing with the pups as well.	For a group living Canid like dholes, social enrichment is vital to ensuring wellbeing in captivity. As shown in our study, the amount of aberrant behaviour decreased when the group was reunited. We recommend that dholes should be maintained in social groups

Summary

The primary problem faced in the dhole enclosure pertained to the two adult dholes that used to constantly perform stereotypical pacing behaviour in front of the retiring cells. We hypothesized that the stereotypical behaviour can be due to the separation from pups by a barrier and the absence of enclosure complexity in other parts of the enclosure.

In the first part of the experiment, we increased the complexity of the enclosure environment by the following methods;

1. Scratching posts
2. Dirt mounds
3. Water pools
4. Pitfall feeders with dressed chicken

We also used certain mitigating measures such as

1. Blocking the path of pacing by providing branches
2. Creating visual barriers between adjacent enclosures and retiring cells

We found that although the mitigating measures such as the blockade significantly reduced stereotypic behaviours, the visual barriers were ineffective as the dholes could still vocally communicate with the pups. Furthermore, the animals instead of performing stereotypical motions started to sit and rest near the retiring cell all day. The increase in enclosure complexity neither ameliorated stereotypic behaviour nor increased species-appropriate behaviour.

Therefore, we decided to release all the pups inside the enclosure along with the adults. This action resulted in a desired change in the enclosure utilization and behaviour pattern of the animals. Immediately we found that the animals were playing and socially interacting with each other. All the animals started using enclosure enrichment devices such as water pools, dirt mounds and scent posts. The animals however remained shy of visitors and chose to perform all activities in the distal zone. The animals tried to pick up the chicken from pitfall feeders a couple of times but were unsuccessful. Due to logistical constraints, we could not perform follow-up studies and in this case, we can only say that probably social enrichment was the solution to the stereotypic behaviour of the dholes.

Therefore, we see that enclosure enrichment cannot be a surrogate for conspecific interaction and animals most often only require a social enrichment to perform speciestypical behaviours. Most animal welfare concerns in Indian zoos can be mitigated if we can maintain every species in naturally immersive enclosure with adequate conspecific contact.

Recommendations

Based on the findings of our short-term study, we recommend the following enrichment options for housing dholes.

1. Social animals like dholes should always be housed together, even in the retiring cell (if it is a family group of parents and pups)
2. Dholes are cursorial animals and are likely to perform movement stereotypy when stressed or welfare is compromised. The topography of the paddock area should be undulating and have vegetation barriers at strategically placed locations so that the animals have to run through various hurdles if they start showing stereotypic behaviour.
3. The vegetation should be dense in dhole enclosures but also provide ventilation to the animals, therefore regular thinning of vegetation should be practiced.
4. Dholes should never be housed in retiring cells with concrete floors, we recommend the type of day kraal used for dholes at AAZP that has a soft substrate of sand and other mixed soil with a low ceiling of wire mesh.
5. Food should be provided in more innovative ways to promote group feeding behaviours that increase social cohesion and promote bonding between related individuals.
6. The enclosure complexity should be regularly changed in order to keep the animals interested.

7. Earth mounds should be placed at least 10m away from fresh water pools. These dirt mounds, encourage denning behaviour as well as autogrooming that allows animals to get rid of ticks and mites.
8. There should be adequate sun basking and shade spots in the enclosure.
9. Water pools are essential for dholes.
10. All natural devices should be used to enrich dhole enclosures as they are very strong teeth and can chew apart any enrichment device. Enrichment devices should pose no choking or poisoning hazard to the housed animals.

Animal Biology and Behavioural Ecology

Felids are considered as an extreme among carnivores for their unanimous adherence to eating flesh, generally of vertebrate prey. They are expert stalkers and killers, with specialized claws for holding and handling struggling prey before delivering a killing bite. The family Felidae has 36 extant species distributed worldwide.

The leopard (*Panthera pardus*) is the smallest of the 'big cats' and Indian leopard (*Panthera pardus fusca*) is one of the nine extant subspecies distributed globally; inhabiting the Indian sub-continent. Leopards are agile and stealthy predators which are usually nocturnal, resting by day on the branch of a tree, in dense vegetation, or among rocks. They move in a slow and silent walk but can briefly run at a speed of more than 60 km/hr. They are reported to leap more than 6 m horizontally and 3 m vertically. Leopards are good swimmers but are not as fond of water as the tiger. They have excellent vision, hearing and sense of smell.

Felids - Essential Environmental Enrichments for Leopard

Chapter 5

They are the most widely distributed of the wild cats, and are found in almost every kind of habitat, ranging from rainforest to desert temperate regions. In India and Southeast Asia leopards are found in all forest types, from tropical rainforest to the temperate deciduous and alpine coniferous as well as dry scrub and grassland, and range up to 5200 m in the Himalaya. It has been reported that 80% of the Indian forest cover are leopard habitat.

Leopards are normally solitary and territorial species. Adults associate only long enough to mate and the young become independent as sub-adults. They are almost always found at least 1 km apart, with spacing facilitated by vocalizing and scent marking with ground scrapes and urine. Fighting in leopards has almost never been recorded.

Table 11 Life history traits of leopard

Spatio-temporal activity pattern	Mostly crepuscular. They are mostly found resting during the heat of the day. However, they are opportunistic hunters who hunt any time of the day.
Foraging strategy	Hunt prey which could give minimum risk of injury. Stash their kill on tree to feed or store
Home range and territoriality	Territorial animals with home range of males is 16.5-96.1 km^2 and that of female is 5.6-29.9 km^2.
Locomotion	Quadrupedal

Activity location	Either on the ground or on trees
Resting/roosting	They are generally found resting on mounds, trees and other such elevated spot which provide them a vantage point
Communication	Communicate through visual signals, scent-marking and vocalizations. Both the sexes of leopard patrol their ranges and scent-mark trees, bushes and rocks with urine mixed with anal gland secretions. Scraping, urine-spraying and tree-clawing are most commonly used by Leopards. Peak calling bouts tend to occur early in the evening and shortly before dawn often while the leopard is moving
Social interactions	Social interaction observed at the time of breeding season and between mother and her cups till their dispersal.
Play	Observed in young, sub-adults and mothers with cubs
Aggression	Fights between leopards are hardly recorded. They growl, snarl or hiss in fear/rage
Parental Care	Mother heavily invests in parental care. Cubs stay with their mother up to 2 years

Minimum Welfare requirements of the species in captivity

Impoverished conditions in captivity effect the animals' natural behavioural reactions and alter species typical patterns. Enclosure type, feeding regime, and the presence of visitors influence the behaviour of captive leopards. The aim of a well-managed *ex-situ* centre is to look after these necessary requirements to maintain both the physiological and psychological welfare of animals. The species is housed in 68 zoos all across India; there are 400 leopards held in captivity. It has been observed that leopards exhibited higher proportion of activity and lower level of inactive periods in enriched enclosures.

Findings from Literature Review

Each cat species has unique basic requirements which need to be considered for ensuring optimum welfare in captivity. For the big cats as a group the following points are to be considered:

1. Geographical and climatic condition of the zoo location; according to which the temperature as well as the settings of the cat enclosures be maintained.
2. Exhibit and retiring area should be large enough for the animal to move around freely.
3. Solitary cats like leopard, in a zoo scenario, are advised to be kept in pairs; however, after checking their compatibility.
4. Feed should always be certified as safe before feeding and should be fed according to individual needs (age, sex, health condition, etc. of the individual).
5. Health and hygiene of the animals should not be compromised. The enclosures should be cleaned regularly and care need to be taken that they are vermin proof. Health of the animals should also be checked regularly.

Findings from Enclosure Evaluation

The enclosure assessment of Common Leopard was done at Malsi Deer Park, Dehradun, Vanvihar National Park, Bhopal and Indira Gandhi Zoological Park, Vishakhapatnam. The following are some of the findings of the assessment:

1. **Barren or monotonous exhibit area:** Lack of vegetation and enrichment devices. Where vegetation was present, it had improper stratification and failed to address the species needs. Enrichment devices used were old without novelty value and static. They were therefore often not used by the animals and posed an eyesore in the exhibit area.
2. **Incompatible pairings/social groups:** Most often solitary animals were found in pairs however, incompatibility between the animals could be observed most of the time.
3. **Predictable and routine way of food presentation:** Feed is always given at the same location and at the same time in almost all the zoos. Pacing and other abnormal behaviours in the animals often increase as the feeding time approaches.
4. **Unequal space utilization of the exhibit area:** Animals were often found using only some parts of enclosure usually those that were close to water source, shed and less disturbed by the visitors.
5. **Limited activity:** Most of the animals were found resting during the day with almost predictable activity pattern day in and out. Lack of stimuli and novelty in the environment promote such kind of activity pattern.
6. **Ill-planned retiring area:** Most often the retiring areas were small with hard concrete floor where animals feed and rest. Most of the zoos lack day-kraals hence, animals that were not released in the exhibit area were locked inside such retiring areas for long periods.

Plate 53: AAZP, Chennai. Top covered enclosure with a continuous viewing area at three sides. Holding area and kraal was visible to the public.

Evaluation of Arignar Anna Zoological Park, Leopard Enclosure

1. Visitor Viewing Area

The viewing area was continuous and 2/3 of the enclosure could be used as viewing gallery. During peak hour crowding occurs around the enclosure. The visibility level was as high as 90%.

Plate 54: High visitor pressure and overcrowding all along the viewing area which was continuous and open almost up to 2/3 of the enclosure

Plate 55: Enclosure enriched with vegetation and furniture of which the animals were habituated. Regular cleaning and trimming of vegetation was required since there was over growth of thorny herbs such as *Mimosa pudica*, etc.

2. Paddock Area Characteristics

The paddock was a levelled ground with no shade during the day; the only shade in the enclosure was present in the retiring area. The pool present was too deep and had vertical sides limiting use by leopards.

3. Enclosure Enrichments

Some enrichments and furniture were provided however, were hardly used by the animal. A climbing structure made of wooden logs was in a poor state of maintenance.

4. Vegetation Features

Vegetation was present inside the enclosure; however, it did not provide perching sites or shade for the animal. Thorny herbs were present inside the enclosure because of which the animal used only certain areas to walk around. Trees present were not big enough to become a perching site for a leopard.

4. Retiring Area

Retiring area was cleaned every day; however, the space lacked any form of enrichment. The animals that were not released to the paddock area were locked inside. There was one small kraal area for this enclosure.

Plate 56: Feed provided on the floor of the retiring cell at the end of the day. Retiring cells received sufficient sunlight and were cleaned each day in the morning

5. Socio-ecology and Behaviour

A pair of animal was released every day during the display time. The male was more active and appeared better adjusted to the captive environment than the female. The male was dominant over the female.

6. Nutrition and Feeding

Food was presented in the same manner in the retiring area six days a week in the afternoon. There was no variation in the diet. **Table 12 Enrichments options for leopard**

	Enrichment Types		Species-typical behaviour targeted
1.	Feeding Enrichment	Hanging meat	Increase activity & foraging time
2.	Sensory Enrichment	Scent trails – peppermint, lavender and blood	Elicit exploratory behaviour
		Introduction of live fish inside the pool	Keep the animals active and busy

3.	**Manipulable Enrichment**	Pebble rattler	Increase play behaviour and keep the animals occupied
		Log perches	Perch and to use for marking
		Platform	Alternate place to perch and feed
		Logs	Increase play behaviour
4.	**Environment Enrichment**	Overhead shade	Equitable usage of space due to presence of proper shade area
		Visual Barrier	Increase equitable usage of enclosure space provided. Create window from where animals could be viewed
5.	**Social Enrichment**	Letting the animal stay singly inside the enclosure	Changes in the activity pattern of the animal

Testing the Efficacy of Enrichments Introduced

Hanging meat: To hang small chunks of meat at different elevated points inside the enclosure.

For our study a kilogram of mutton with bone was brought everyday as feeding enrichment. At least three pieces were cut from the meat and hung from tree branches and upright logs using coir or jute rope.

Findings:

Plate 57: Meat being hung on a tree inside the enclosure

a. Activity increased for the male and prompted him to climb trees and logs where the meat pieces were hung.

b. Care need to be taken that the bones/left-over are cleaned before the animals are release again for exhibit.

Log Perches & Platform: Furniture to perch, feed and rest on.

a. Log perches

Wooden logs big enough for the animals to rest were put up as perches at different locations inside the enclosure. Cut logs were laid horizontally on two bifurcated logs at each end, erected from the ground at a height of about 1.5 m and 1.2 m. 1/3 of the erected logs length was buried into the ground to make sure they stay firmly erect. Iron nails were avoided to reduce chances of injury, ropes were used to fasten the logs together.

Plate 58: Leopard showing new activity such as climbing up on trees and perching after enrichments were introduced inside the enclosure

Plate 59: Log perches being constructed

The perches were made in such a way that the animal could easily jump up and rest comfortably on it. Both the perches also had connectivity to the neighbouring tree such that if the animals chose to, they could jump or lean on the branches of the tree.

Plate 60: New tree log perches introduced inside the enclosure located at different zones **b. Platform**

A platform of approximately 1.2 m height was constructed out of logs beside the pool and under a tree to provide an elevated space where the animals could lay down to rest, sit or feed. It was also made with the idea of providing an alternative withdrawal area, especially for the female since it was close to the corner where she sat.


Bifurcated logs smaller than those used for perches, were erected at four corners at about 1m x 1.2 m dimension. Smaller logs were laid horizontally on the forked erected logs on two sides as a frame. Then Logs were laid across these one after the other with the help of coir ropes to create an elevated resting place.


Plate 61 Setting up of platform

Findings:

a. The male leopard was observed to use all the furniture put up. He was constantly seen resting, rubbing his neck and head on them.

b. The platform and log perch next to it was especially used as a means of reaching up for the meat suspended from the nearby tree.

c. Care need to be taken that metal wires or the iron nails do not get exposed and that the perch/platform does not get wobbly. A routine maintenance check is required.

d. Furniture should preferably be put up in such area where the visitors can view the animal while at the same time the animal gets some distance and seclusion

Plate 62: Interaction with platform where the leopard performed various activities. The leopard jumped on it, sat and rubbed itself on its surface.

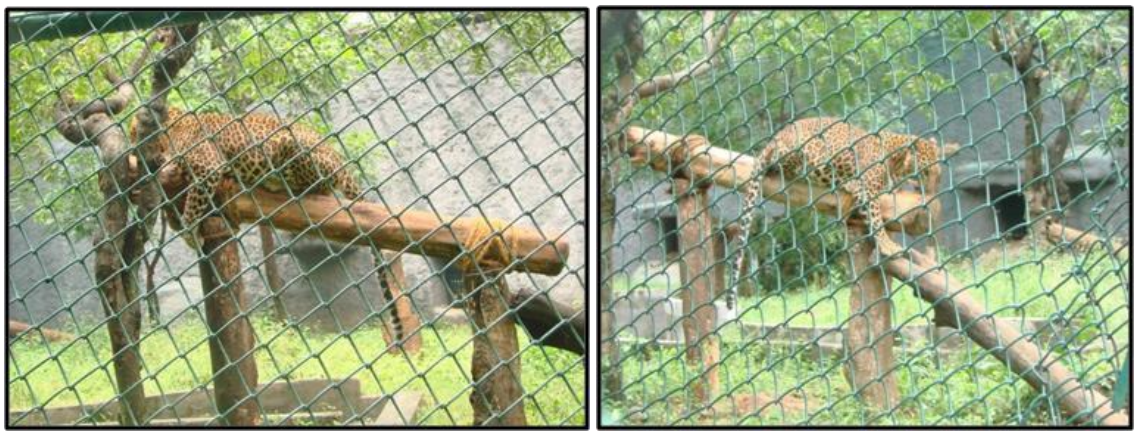


Plate 63: Leopard interaction with log perches located at different zones of the enclosure. It often sat atop and rubbed its head on the log

Plate 64: Interaction with various enrichments. The leopard used the log perch and platform to reach out for a meat piece hanging on the tree

Logs: As toys/substrate to play, scratch or rub on.

a. Tree logs were randomly placed or leaned along vertical surfaces throughout the enclosure. They were especially used to spray scents inside the enclosure and short stump logs were laced as

Plate 65: Logs at different zones of the enclosure toys for the animals to play with.

Findings:

a. Logs were used as a means to show many natural behaviour of the animal such as scent marking, scratching, etc.

b. Smaller logs such as stump or cut block were observed used as toys to play with.

c. Care need to be taken that the logs provided especially those used as toys are free from splinters to avoid injury.

Scent Trail: Sensory enrichment

Scent marked on trees and logs as well as scent trail across the enclosure during the enrichment study. Lavender and peppermint oil were used for two days while blood trail was used for a day for the experiment.

Findings:

a. Not much change in behaviour could be observed while the lavender and peppermint oil were used.

b. The male leopard was observed to follow blood trail across the enclosure and was seen sniffing on those areas scented with blood.

Live Fish: Sensory enrichment

The pool present inside the enclosure was cleaned and water was changed. Then ten Golden Carps were introduced a day before the post-enrichment study started. These carps were chosen since they are surface dwellers and have striking colour. The carps were caught and brought from the zoo aquarium pool and it took them time to adjust with their new environment.

Plate 66: Releasing carps inside the pool

Findings:

a. This enrichment did not elicit a positive response from the animals. The possible explanations are:

1. We released only 10 carps in the pool and the number was small when compared to the size of the pool.

2. The depth of the pool was more than 1.5 m and it had vertical sides making it difficult for the animal to use the pool.

3. Study was conducted before the fishes could acclimatize with the new environment since they were mostly found together in one corner.

b. The above given points should be considered for any future enrichment of this type.

c. Care should be taken while considering the type of fish species to be used.

Pebble Rattler: Toy to keep the animal occupied

A wooden box of about 30x30x30 cm^3 was taken which had few pebbles to make noise as a rattler. The box was then wrapped with layers of Hessian cloths to minimize the impact of the getting hit by the box especially its edges. It was then attached to coir rope and hung from a tree. This prototype was planned to elicit play behaviour of the animal and to increase their activity.

Plate 67: Setting up pebble rattler

Findings:

a. Interest of the animal waned quickly since its claws get stuck to the Hessian cloth used to wrap the box.

b. However, presence of food reward ignited the interest again. This means the enrichment device is most effective only with the presence of something to feed on.

c. Change of enrichment device material could increase the interest level of the animal.

Plate 68: Manipulable enrichment pebble rattler hanging from a tree

Plate 69: Leopard interaction with pebble rattler

Overhead Shade: To balance out the unequal use of space inside the enclosure due to absence of adequate shaded areas.

Green agro-net was used to provide shade over a select portion of the enclosure which otherwise was too sunny for the animals during the day. An area of about 30x20 m^2 was covered on the wire mesh overhead.

Plate 70: Agro-net on the top of the wire mesh leopard enclosure

Findings:

a. The area where the agro-net was put up was decided based on the direction of the sun and the area that lacked shade.

b. This provided an option for the animals to use the enclosure though no much change could be observed during the study period.

Visual Barrier:

Visual barriers of at least two meter high was created using mats made of dried palm tree leaves at some of the viewing sides of the enclosure. The view to the kraal area was also closed using these mats. Only the proximal side of the enclosure was left open for the visitors.

Plate 71: Visual barrier made of palm leaves at one side of the enclosure

Findings:

a. Viewing area of the enclosure was reduced and visitor crowding at almost the entire periphery of the enclosure was controlled.

b. No major behaviour change could be observed during the study period however, it helped in providing some seclusion and withdrawal area for the animal.

c. More permanent and naturalistic barriers could be planned.

Summary

Enrichment of leopard enclosure at Arignar Anna Zoological Park showed the possibilities and difficulties of planning, executing and assessing various ideas of enrichment on ground. Response to enrichments items by the individual animal was totally different though they were kept in same captive environmental conditions. Besides knowing the biology of the animal, getting to know its history and personality is important especial for solitary or individuals bin a small group of animals for successful enrichment interventions.

Enrichment plan and action should be based on the structural design of the enclosure and need of the animal present. Material required should also be locally and readily available. The enrichment planned for our study was in an experimental mode; however, other enrichments can also be tested and an

enrichment plan based on the response received by the animals developed for use at the zoo.

1. Problem identification is a very important step that should precede every enrichment intervention.
2. Enrichments and scientific management practices reduced the level of aberrant behaviour to some extent.
3. Any enrichment that promises food reward at the end is the biggest motivation for the study subjects. Therefore, more reward based enrichment approach could be incorporated in future plans.
4. Manipulable enrichments which are not food reward based work well only for short durations and therefore these kinds of enrichment should be constantly changed or incorporated a least with food scent on them.
5. The sensory enrichment provided received poor response from the animals; however, since it was tested only on two individuals with very diverse background history it would be too early to assume that it failed.
6. Food based enrichments caused positive changes in the activity and behaviour patterns of the animals studied.
7. Enrichments should be planned according to individual needs of the animals especially that of solitary species or different individuals in a group living species and the status-quo between con-specifics should be maintained.
8. Since individual personalities differ, responses to enrichment could also be completely different as in case of our study subjects.
9. Enrichment interventions should not lead to undue stress and aggression between conspecifics.
10. No enrichment plan or design is perfect or fixed for specific species and there should always be a scope of improving or improvising it. There has to be a constant change and innovation.

The family Ursidae is represented by eight species of bears found all over the world inhabiting diverse habitats apart from Australia, Antarctica, and Africa. India is home to four of these, which includes the Brown Bear (*Ursus arctos*), Asiatic Black Bear (*Ursus thibetanus*), Malayan Sun Bear (*Ursus malayanus*) and the Sloth Bear (*Melursus ursinus*). Ursids make for attractive exhibits in zoos and attract visitors by their activity patterns. Enclosure assessments for studying the existing housing and enclosure enrichment practices in Indian zoos were carried out for two identified ursids *i.e.* Sloth bear and Asiatic black bear. Based on this study an enrichment plan for ursids in Indian zoos was developed using Asiatic black bear enclosure at M.C. Zoological Park Chatbir as a study site.

mountainous areas. These bears are also seen in moist tropical forests. Sometimes these bears might be found residing at elevations above 4,300m. However, *U. thibetanus* will climb down to lower altitudes as the weather gets colder. The Black bears are often found foraging in open alpine meadows. Primary diet of Asiatic black bear includes, vegetation, insects, and fruits in summer. In autumn, they like to feed on nuts. In some areas meat from mammalian ungulates also forms a large portion of their diet, whereas in other areas the species feeds on livestock like goat, sheep and cattle. Black bears like to den on flat surface. During a study done on the Min Mountains of China it was found that the Home ranges of Asiatic Black Bears varied widely from 3.9-96km^2 for females and 3.2-123km^2 for males.

Ursids: Essential Environmental Enrichments for Asiatic Black Bear

Chapter 6

Plate 72: Asiatic black bear resting on an artificial kumadana(platform) at Mysore Zoo

Asiatic Black Bears prefer to dwell in heavily forested In some of the temperate forests, the black bears tend to consume hard mast in order to accumulate sufficient fat reserves for the winter months. Sometimes the males might even exclude females from rich stands of hard mast. Asiatic Black Bears also use regenerating forest that have a high production of berries. The black bears raid cultivated areas like

corn plantations, fruit orchards. The bears are known to den in rock crevices, hollow tree and tree stumps, while dug-out earthen dens are preferred for hibernation.

Table 13 Life history traits of Asiatic black bear

Age at first reproduction	4 years
Estrous cycle	NA
Weaning age	Infants stay with mother until 2 years of age
Inter-birth interval	2 years
lifespan	30 years
Mating season	June-July
Mating system	Promiscuous

The sows generally have their first litter at the age of 3 years and the average litter size 1-2 cubs. The cubs are born blind after a gestation period of 200-240 days. The sows give birth in caves or hollows of trees. The cubs can see properly from the 3rd day and they start walking from the 4th day.

Behaviour and Social Organization

Very little is known about the behaviour of the Asiatic Black Bears in wild. It has been seen that Asiatic Black Bears are usually solitary. Only mothers with off-springs till they are sub-adults are known to move around in groups. Although Asiatic Black Bears are usually diurnal, in some areas they have become nocturnal to avoid interaction with humans.

Studies on activity patterns of Asiatic Black Bears suggest that like all other tropical bears, they remain active throughout the year. However, in temperate zones they may hibernate during winters. They start collecting nest material from mid-October and go to hibernate from November until March. It has been seen that barren female black bears come out of hibernation earlier than those with offspring.

Black bears have a rhythmic motion and they move in a sure-footed way. While running, they can reach top speeds of 40-50kmph; however, they can maintain their top speed only for short sprints. They are excellent climbers and sometimes they make rudimentary nests on the trees to rest and feed. In addition to that, they are known to be highly dexterous, they can open screw-top jars with their forelegs. These animals have immense strength in their forelegs. They have a keen sense of sight and they can easily distinguish between differently shaped objects.

Food and Feeding Behaviour

Before considering the diet of Asiatic black bear, we must understand the dentition and cranial morphology of ursids. Sun bears, Andean Bears, Asiatic and American Black bears are omnivorous in nature compared to Brown and Polar Bear (carnivores), Giant Panda (herbivore), and Sloth Bear (insectivore). As evident from the size of lower molars (which is used to masticate vegetation); is smallest for the Polar bear, brown bear and sloth bears because of the lack of vegetation in their diet. Giant panda has the biggest lower molars followed by the Asiatic Black bear, suggesting that vegetation forms a large part of its diet. The distinguishing cranio-dental feature of the omnivorous bears include blade like canines (weak against lateral forces exerted by a struggling prey) and powerful jaw muscles. The blade-like canines is similar to canids, which take short shallow bites of the prey. The powerful Masseter muscles are similar to felids with huge bite forces that hold their prey down for a longer time, so ideally the omnivorous bears should have more rounded canines to be efficient hunters (i.e. to hunt prey larger than their body size). Furthermore, the killing behaviour of Black bears does not consist of deep bite wounds on preys, therefore the large masseter muscles are probably used to process the large amount of vegetation consumed by these omnivores on a daily basis.

Studies on the feeding ecology of Asiatic Black Bear in the Dachigam National Park in Jammu and Kashmir, India and Kedarnath Wildlife Sanctuary in Uttaranchal, India suggest that they are omnivores; however, the food of choice consists of acorns, fruits, nuts, honey, and roots. The diet also includes of termites, beetles and larvae. The diet depends on the season as well as the availability of food. During autumn they feed on acorns, chestnuts, walnuts etc. spring is the time to feed on bamboo, raspberry, hydrangea etc. During summer, they feed on raspberries, cherries, grasses etc. They are also known to attack and feed on livestock and cattle.

In Thailand the Asiatic Black Bear is known to feed on more than 160 species of treeborne fruits. In China, they shift from leafy material in the summer diet, to fleshy fruits and then to fat-rich fruits before hibernation. In the Dachigam National Park of India, they show a similar shift in diet preferences. Similarly in Kedarnath Wildlife Sanctuary they consume fruits with high sugar-content in summer and autumn. They play an important role in germination of seeds of (*S. theifolia*), it appears that feeding by the mean length of dormancy of the seeds is reduced and germination rate is increased.

Reproductive Behaviour

The Asiatic Black Bears usually breed during the months of June-July and they give birth between November–March. The adult male black bears show the greatest movement during the breeding season. The lifespan in captivity can be around 30 years but survival is lower in the wild. The offspring remains with the mother until they are 2 years old and after that, they start out on their own. Pregnant Asiatic Black Bears often reject food.

Minimum Welfare Requirements of the Species in Captivity Housing Features Findings from Literature Review

1. **Social Grouping:** In captivity, bears are often housed in groups, which might induce conflicts. Housing same sex individuals in a confined enclosure often leads to a higher amount of stress in the subordinate individuals.

2. **Space Constraints:** Captive environment limits their movement, and fails to give them necessary stimulation to stoke their curiosity.

3. **Climbing and Other Activities:** Captive environment restrict natural behavioural traits such as climbing, digging, burrowing, swimming and various other activities. Even if an enclosure provides climbing opportunities to animals, the provision of processed food in retiring cells inhibits the motivation for performing such tasks.

4. **Food:** In the wild bears forage on wild berries, insects, carrion, birds, eggs, tubers and various other food items spending a significant portion of their daily activity budget on finding preferred food items to meet their energetic requirements. In a captive environment, bears are fed cooked food items with high carbohydrate content. The animals eat most of the food items within a short time and stay inactive for rest of the day. This leads to a higher incidence of obesity-related diseases in zoo animals.

5. **Inappropriate Retiring Cells:** Asiatic black bears are large animals that require night shelters/retiring cubicles bigger than that provided in most zoos. Lack of ventilation and lighting may lead to pathogen build-up. The design of most retiring cubicles limits vertical and movement and has limited space for movement.

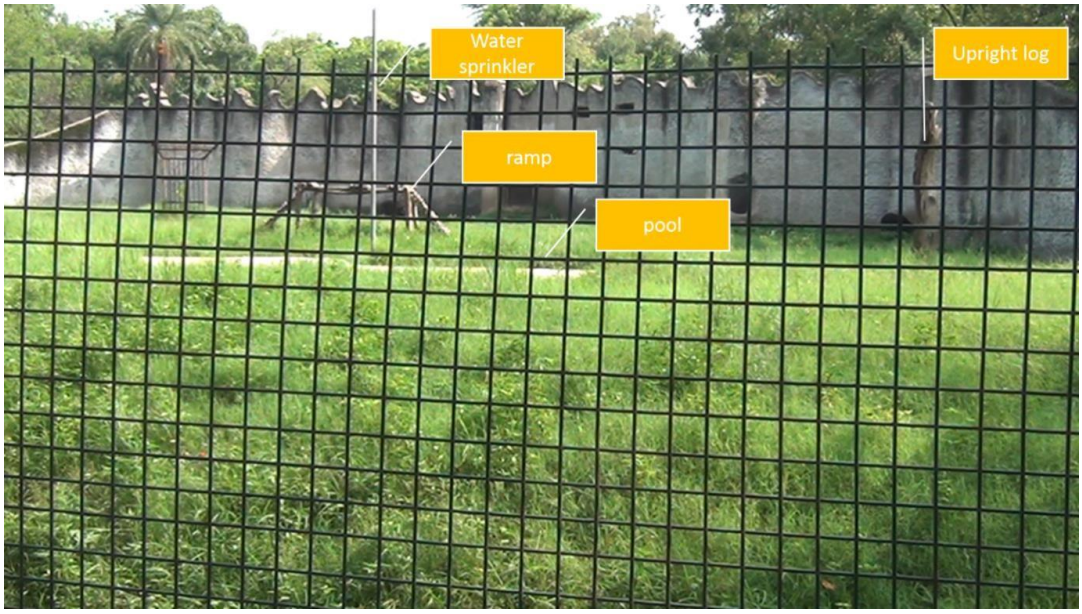
FINDINGS FROM ENCLOSURE EVALUATION

The assessment of the housing and enclosure enrichment practices practiced at Mahendra Chaudhary Zoological Park Chatbir (MCZP) are summarized below:

Plate 73: Asiatic black bear exhibit at MCZP

Housing and Enrichment Conditions at MCZP

The MCZP exhibit for Asiatic Black Bear is around 1782 m^2 in area and covered grassy vegetation. The enclosure houses a heterosexual pair of Asiatic black bears as the following attributes.



Visitor Viewing Area

The viewing area at MCZP is continuous and provides unhindered view to the visitors. Therefore, the animals have very little withdrawal space and have to utilize the moat to stay away from the visitors.

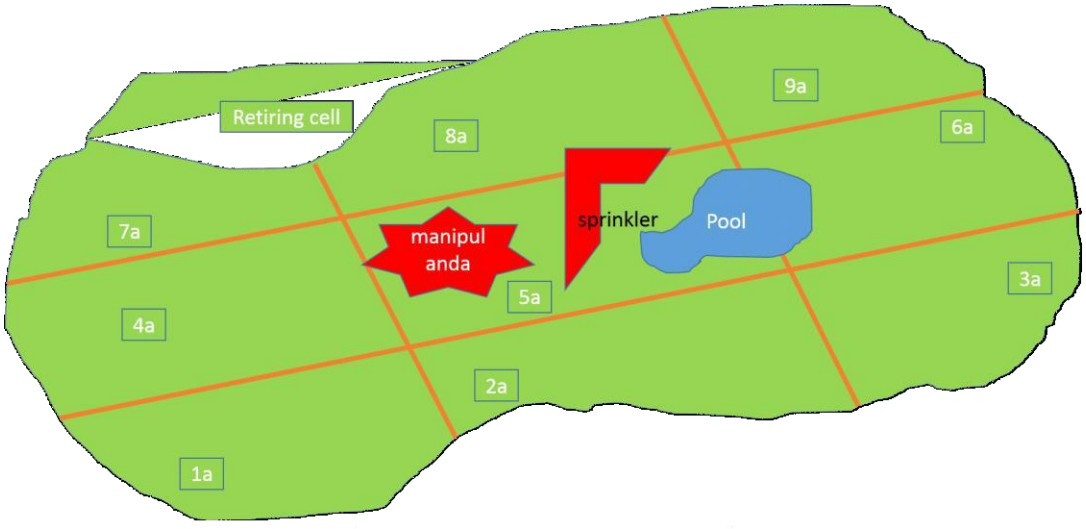


Plate 74: Existing enclosure schematic plan

Enclosure Design

Asiatic black bears are known to climb trees in the wild and forage on fruits and stingless beehives. The enclosure at MCZP has an open-air dry moat design that promotes animal movement and space use.

Vegetation

The vegetation at the Asiatic black bear enclosure provides refuge to insects and therefore they might be helping the animals acquire supplementary protein which is absent from the zoo-diet; however, the lack of stratification due to absence of trees and shrubs hinders the animals from displaying their full scope of natural behaviour repertoire.

Furniture and Enrichment

Enriching ursid exhibits has often led to a large (upto 80%) decrease in stereotypies. Furniture present in the enclosure included a ramp, a sprinkler and a pool. The lack of species-specific furnishing and enrichment devices imparts an unnatural look to the exhibit and is reflected in the level of stereotypy displayed by the animals. Four iceblocks are provided at the retiring cells for each animal every day; however, the retiring cells are small (present dimensions 3mLX2mBX3mH).

Nutrition

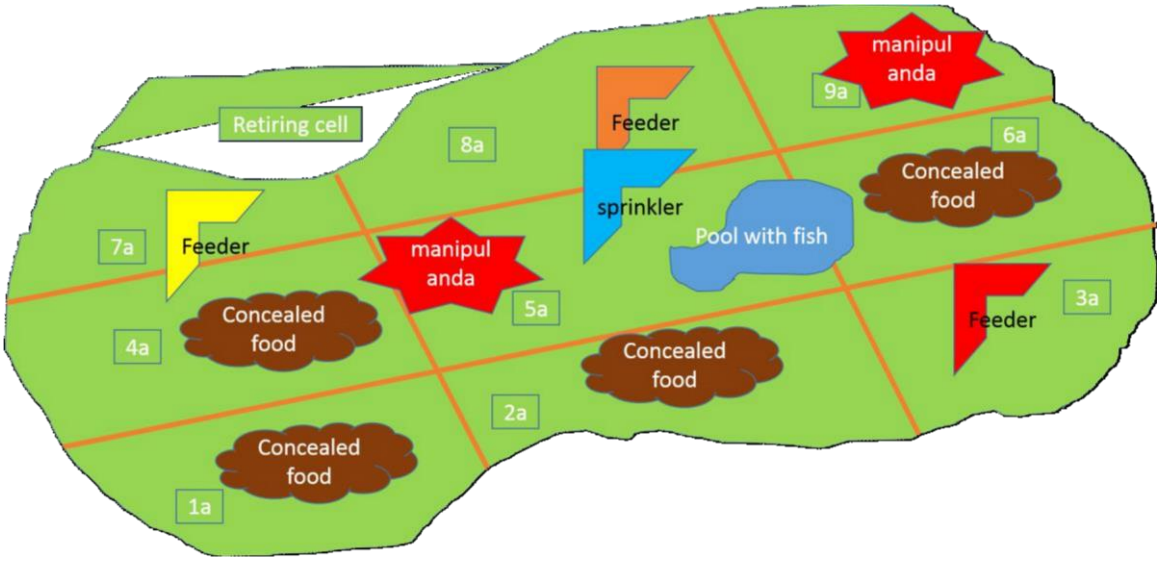
The food provided to the black bears at MCZP has some resemblance to the natural diet of the species; however, the diet also included a large proportion of processed food. These processed food products are a high source of gluten and can be harmful to the animals. The diet provided at MCZP is compared to the natural diet in the table below.

Table 14 Diet of Asiatic black bear at MCZP

Zoo Diet	Quantity	Wild Diet	Comments
Maize roti	250gms	Berries	250gms
Milk	500gms	Nuts	500gms substitute for hard mast
Bread	200gms	Corns	500gms
Apple	300gms	Apple	Increase quantity may substitute soft mast
Banana or Papaya	3/1	Banana is a tropical fruit which is not usually found in Black bear habitats the zoo might consider replacing it with some other fruit from the range of black bears	
Sweet Carrot	100gms (Nov-March)		
Khichdi (Rice: mungi=1:1)	1kg	Needs to be changed	
Honey	100gm (Only	Novel delivery methods should be devised	

Conclusions from Enclosure Assessments

Based on the enclosure evaluation studies conducted at MCZP we found that the median and proximal zones of the exhibit were least utilized by the animals throughou the day and we can encourage more species typical behaviours by enriching the underutilized portions of the exhibit. The enrichment plan will try to provide the animals with stimuli that promote species typical behaviours



	during winter)		

Plate 75: Proposed enrichment plan at MCZP exhibit

1. The male shows more stereotypy than the female throughout the day (even after feeding) therefore it requires special attention.
2. The female shows more foraging behaviour than the male and the behaviour peaks at early morning. The foraging peaks of the two animals never coincide.
3. The female shows more activity at the beginning of the day while the male shows a heightened activity at the latter part of the day.

Table 15 Enrichment options for Asiatic black bear

Enrichment Device	Enrichment type	Materials required	Location	Species-typical behaviour Targeted
Artificial Den	Permanent fixture provides shelter	Concrete tube (diameter 2m and length 4m) the concrete tube will be covered on top with soil and logs to give it a natural look and the den will be oriented with both ends facing the visitor area so	Area 9a,	Resting, withdrawal area, shelter from inclement weather

		that the visitors may be able to see the animals when they are resting.		
Boulder placed next to the sprinkler	Permanent fixture	Big boulder dome shaped with an irregular surface at least 2m in height and 3m base diameter	A boulder placed next to the sprinkler will provide micro-	Resting, thermoregulation and foraging

Enrichment Device	Enrichment type	Materials required	Location	Species-typical behaviour Targeted
			climatic variations in the enclosure providing alternate areas to rest for the animals. The boulder will also encourage growth of insect colonies and enhance foraging opportunities in the exhibit	

Separate entry to the enclosure	Permanent fixture, sensory enrichment	Height 2m and width 1.5m. The door will be placed above the moat near area 7a and entry into the enclosure will be through a retractable ladder, which will reduce wear and tear on the door	The separate entry point will help zoo keepers enter and exit the enclosure with enrichment items and food for the animals	Easier to implement enrichments with a separate entry point.
Pitfall feeder	Feeding enrichment, manipulable enrichment	2ft pvc pipe of diameter of 10 inches placed at different zones of the exhibit and loaded with enrichment items like eggs, raisins, nuts etc.	2a, 3a, 8a	Foraging and exploratory behaviour
Wobble tree	Feeding and Manipulable enrichment	20ft tall log with 6 ft underground and 14ft on the surface. The log should have bark on it and a basket of diameter 1ft with holes on all four sides big enough to let nuts and raisins fall to the ground when the log shakes. Will need to be loaded at the beginning of the day	6a	Foraging
Hessian bags	Feeding and manipulable enrichment	Six hessian bags with hay and food hidden inside will be provided each day to the animals. Extra hessian bags will be provided with hay and no food inside. While some of the hessian bags will be placed on the ground, some will be placed on top of upright logs so that animals have to climb up to access these enrichment devices. Some of the hessian bags will be buried underground to promote digging and foraging behaviour.	7a , 3a	These upright logs will help the bears scratch with their claws, rub their backs against the log and get rid of ectoparasites.

Upright logs	Manipulable	Four logs will be placed		The animals can
Enrichment Device	**Enrichment type**	**Materials required**	**Location**	**Species-typical behaviour Targeted**
	and feeding enrichment	adjacent to each other and tied so that the bears can climb on it. Holes can be drilled on to the logs and small treats like raisins. The logs should be more than 12ft tall above the ground and an additional 6ft under the ground, with concrete on the sides of the holes to ensure stability.		scratch against the logs, climb on them to search for food, The exploratory nature of bears can be encouraged through these upright logs
Branch piles	Manipulable and feeding enrichment	Small logs 20-30 of them of length 3ft and diameter 8 inches can be used to make piles at different locations and loaded with small treats like nuts and raisins		Promotes exploratory behaviour, play behaviour etc.
Scratching posts	Manipulable and sensory enrichment	Single upright logs with rough bark will help the bears autogroom themselves by rubbing their back on the logs	1a, 3a	Promotes autogrooming and other behaviours such as scratching etc.
Feeding Schedule and Area	Management Practices	We have observed that the animals do not use the paddock area after feed was given at 1530 hours. We strongly recommend that the food be provided at the paddock area and not in the retiring cells. The food should consist of natural unprocessed food products found in the natural habitat of the target specie (Asiatic black bear).	Food can be provided at the medial portion of the exhibit	Promotes enclosure utilization. Helps animals display more speciestypical behaviours.

Testing the Efficacy of Enrichment Devices and their Combinations

Enrichment Devices Implemented

Ice blocks and frozen treats	Sensory enrichment, contrafreeloading	Ice blocks are already provided to the animals at the retiring cells, we propose increasing the number of ice blocks and providing them at the shelter in the paddock area. Fruits with high moisture content such as grapes and apples can be frozen in a bucket of water and provided to the animals	6a, 9a	These enrichments will help the animals thermoregulate and increase their foraging time (frozen treats). These enrichments should not be implemented during Winters if the temperature is below 17 degree Celsius.

Plate 76: Pitfall feeders at Asiatic black bear enclosure Chatbir

1. Pitfall Feeders:

Pitfall feeders were made from steel pipes of diameter 260mm and height 920mm. The pipe edges were smoothened so that there was minimal chance of injury for the animals as they reached out to get the food. We placed nine pits across the proximal and median zone of the enclosure. Each day a random set of six pits were filled up and three were left without any food rewards. Later, as the animals started showing preference for certain type of food items, we started a mixture of high and low preference food items, so that the animals had to spend a longer amount of time processing the food.

Findings:

a. Pitfall feeders were highly successful for both the individuals

b. Since the pitfall feeders were loaded at random, the animals did not know which pit is likely to have a highly preferred food resource and therefore they had to forage around the entire enclosure to check out all the pits.

c. The animals on an average spent at least 30 minutes of foraging time on each of the pit feeders

d. The large distance between pits allowed animals to forage without having any aggressive interactions between conspecifics

e. The distance between enrichment devices reduced competition for food resources. Therefore, the older female could retreat to a different part of the enclosure and forage on food after being displaced by the stronger male. The spatial heterogeneity of enrichments allowed us to reduce aggression between animals to a high degree.

2. Wobble Tree

The MCZP enclosure lacked vertical structures and the animals had no scope of showing climbing behaviour. Therefore, we set up wobble trees inside the enclosure so that the animals may get the opportunity to climb these structures. As an incentive we attached fruits and other treats at a height of 2.5 meters from the ground. The wobble trees had scooter tyres at the base, therefore when a bear attempted to climb the structure it would sway a little but would never get uprooted. To facilitate climbing behaviour we tied coir ropes to the base of the tree so that the animals could get a good grip on the tree, even under rainy conditions.

Plate 77: Installation of wobble tree at Asiatic black bear enclosure

Findings

a. We found that the animals were using the wobble tree (manipulanda) regularly to get food rewards.

b. Although the animals preferred to eat fruits from the pits at the beginning of the day. However when that resource was exhausted and feeding time arrived, instead of pacing and circling around the retiring cell, the animals started using the wobble tree to gain access to honey feeders and other high resource value food items.

3. Bamboo Feeder/ Honey Feeder

The bamboo feeder was constructed out of bamboo stumps and had a very simple construction. With the help of a drilling machine and a saw we were able to fabricate more than 20 such devices on a single day. These devices had a stopper placed on the top that made it very difficult for animals to get access to all the food at one go and on the other hand the bamboo feeder could be hung from a top branch of a wobble tree to promote the climbing behaviour of the subjects. Holes were made at the bottom of the bamboo **Plate 78:** Bamboo feeder setup and use by Asiatic black bear

feeder so that the honey would trickle down slowly and thereby encourage the animals to climb the structures. Sometimes we also placed bamboo feeders inside the pits and forced the animals to use their dexterity to gain access to these food resources. The bamboo feeders were sometimes filled with a mixture of bread, milk, apple etc. and the animals would spend a large amount of time to get rid of the wood stopper, which increased the food processing time.




Findings

a. The bamboo feeder successfully increased the food processing time of the male black bear.

b. The male was agile and under normal circumstances finished food resources faster than the female. Therefore the female might suffer due to her slow speed. In order to slow the male black bear down and stop him from consuming all the enrichment items, we placed these bamboo feeders. Once the male started using the

bamboo feeder, it was stuck at one location while the female could forage around the enclosure.

c. Usually we found that the bamboo feeder acted as a toy for the Asiatic black bear male as it was frequently found playing with empty feeders for long intervals.

4. Hanging Fruit

We used covered and uncovered fruits and vegetables to create a treat for the animals. Since fruits are usually found on trees, we promoted natural behaviours like climbing by providing feeding enrichments on a log.

Plate 79: Closed type hanging fruit

Plate 80: Open type hanging fruit

Open type: The open type of hanging fruit enrichments were used during the first part of the study to sensitize animals to the presence of enrichment devices. Later on we found that the open type of hanging fruit enrichment reduced the foraging time.

Plate 81: Asiatic black bear foraging on hanging fruits

Closed type: The closed type of feeding enrichment included small sections of gunny bags with compartmentalized sections with fruits in them. These compartments were independent of each other. Therefore even though animals gained access to one

compartment they could not access the others right away. It took multiple attempts by both the animals to finish the closed type hanging fruit enrichments.

Findings

a. The two Asiatic black bears at MCZP were very different from one another. One was a young male that was very agile and curious about its surroundings and it also showed a lot of displacement behaviour. The other animal was a partially blind older female that did not display any aberrant behaviour and rested for most of the time. The hanging fruits enrichment was designed to lure the young male so that it can vent off some of its energy in performing exercises.

b. Since both the animals had distinct food preferences, we loaded only food items highly-preferred by the male so that only he will find it frugal to spend such a high amount of energy for small food rewards.

c. By making it very difficult for the male to get at enrichments we ensured that the slow-moving female had enough time to get to the easily obtainable food resources.

5. Honey Lick

The honey licks were used as olfactory stimuli to incite the senses of the animals. We used 100ml of honey mixed with 200ml of water and a paint brush to make scent trails leading to enrichments and coat less-preferred food items in order to make them more enticing to the animals. The purpose of the honey lick was two-fold.

Plate 82: Sensory enrichment being utilized by Asiatic black bear

a. It acted as a sensory enrichment, which allowed the animals to track down food using their acute olfactory capabilities.

b. The honey lick also helped us trick the animals so that they would spend a lot of time looking for food at certain locations, where there was none and thereby increase their foraging time.

Findings

a. The honey licks proved highly effective in luring the animals to novel enrichment devices.

b. The smell of these enrichment interventions were highly effective in attracting animals toward other enrichment devices.

6. Ice Blocks and Shelter

Asiatic black bears are found in temperate habitats and therefore require a cool climate to maintain homeostasis. The MCZP zoo is outside the distribution range of the species; however, the zoo provided ice blocks to help animals to thermoregulate. The enclosure lacked vertical features and apart from the moat the animals had limited

Plate 83: Ice blocks and shelter provide opportunity for thermoregulation to Asiatic black bears access to shade. Therefore we setup up an impromptu shelter using agronet sheets

sewn together and attached to the retiring house on one side and logs on the other side of the enclosure. Although these shades looked unnatural, they provided a shaded cooler area for the animals. Additionally; we wrapped two ice blocks in gunny bags and placed them under the shed. The gunny bags helped reduce the rate at which the ice was melting and provided the animals with a cool place to rest.

7. Manipulanda

Manipulable enrichment devices are an integral part of an enrichment plan.
These devices provide the structure and complexity to increase the activity levels of the animals. These manipulable enrichment devices or manipulanda can be used in harmony with other feeding and sensory enrichments and provide a nice platform for complexity design. The manipulable devices inside the enclosure included the following

1. Upright logs:
2. Moving branch with food items
3. Wobble tree

We have already discussed the wobble tree in detail. The upright logs provided vertical features inside the enclosure and therefore afforded the bears with the opportunity to show climbing and foraging behaviour. Apart from their obvious functional features, these logs also improved the aesthetics of the enclosure. We knew that the fresh upright logs would be debarked soon; therefore three layers of coir ropes were wound from the base upwards, to provide a better grip for the animals.

Hanging food items on manipulanda

8. Hessian Bags

The Hessian bags were filled with grass and some tasty treats such as whole apples, cucumbers and corn cobs. The animals had to tear apart the bag to get through to the food inside. This was our experiment in using contrafreeloading techniques to make animals work for their food. The gunny bags were filled with fresh grass every day and kept at different locations of the enclosure.

Plate 85: Asiatic black bear using a manipulable hessian bag with hidden treats

We discovered that the hessian bags were not very successful as the animals often ignored the enrichment item. Other problems encountered include the following:

Plate 84: Hanging food items on manipulable enrichments being utilized by Asiatic black bear enclosure. **Findings**

a. There was a remote possibility that the animals would ingest the jute fibres. We soaked the bags in water overnight get rid of chemical residues but the concern remains. However we never found the animals consuming the jute fibres.

b. The grass was gathered from outside the enclosure and therefore could carry pathogens that might lead to diseases.

c. Most of the food items in the hessian bags were left undiscovered and there was a lot of wastage as well.

Due to the safety concerns associated with hessian bags, we discontinued the enrichment device after two implementation attempts.

Table 16 Efficacy of enrichment intervention at Asiatic black bear enclosure

Pre – enrichment feature	Modified enclosure feature	Needs addressed	Efficacy of enrichment post enrichment study

Lack of novelty in the enclosure environment	New enrichment devices implemented	Boredom and lack of opportunity to perform instinctive behaviour mitigated	The animals started showing diverse behaviour repertoire
Enclosure space unevenly utilized	All enclosure zones were provided with feeding and sensory enrichments	The animals could now forage and move through the enclosure in search for treats	The daily movement of the animals increased. All enclosure zones equally utilized
Pre – enrichment feature	**Modified enclosure feature**	**Needs addressed**	**Efficacy of enrichment post enrichment study**
Animals show a high preference for distal areas	Enrichments were placed at distal, median and the proximal zone	Animals had to move through all parts of the enclosure to use enrichment devices	
Animals display aberrant behaviour patterns	Most of the aberrant behaviours were a part of the displacement activity shown by the animals as they wanted to move into the retiring cell from the paddock area	The complexity of the paddock area was increased to provide equal opportunities for the animals to display species-typical behaviour patterns	The level of stereotypical aberrant behaviour significantly decreased

Summary

To summarize we can draw the following conclusions from our observations

1. Enrichments and scientific management practices effectively reduced the level of aberrant/repetitive behaviours in the study subjects
2. Food is the biggest motivation for the study subjects and therefore all enrichments were designed based on a reward-based positive reinforcement approach to make the animals spend more energy to get miniscule food rewards.

3. The enrichment plan worked perfectly for the first few days, but ursids being intelligent at problem solving started to notice the pattern. So we constantly changed the location of certain preferred food items across the enclosure. Therefore ensuring that the animals had to visit all the possible foraging sites in order to get their choice of food items.

4. At each of the pits, we put a mix of foods with high processing time and low processing time. This ensured that the animals could not move through all the enrichment items very fast. The complexity of the food items forced the animals to spend significant amount of time on each enrichment.

5. Therefore, we realized that enrichments need to be individual-centric and should also look at the *status-quo* between enclosure mates. Enrichment interventions should not lead to undue stress and aggression between them.

6. The enrichment intervention performed at MCZP Asiatic black bear enclosure supports the theory that enclosure enrichment interventions have to be made at the individual level. The personality of the animal concerned and the location of the enclosure should be taken into consideration before drawing up enrichment plans.

7. Problem identification is a very important step that should precede every enrichment intervention.

Small Mammals: Essential Environmental Enrichment for Red Panda

Chapter 7

Animal Biology and Behavioural Ecology

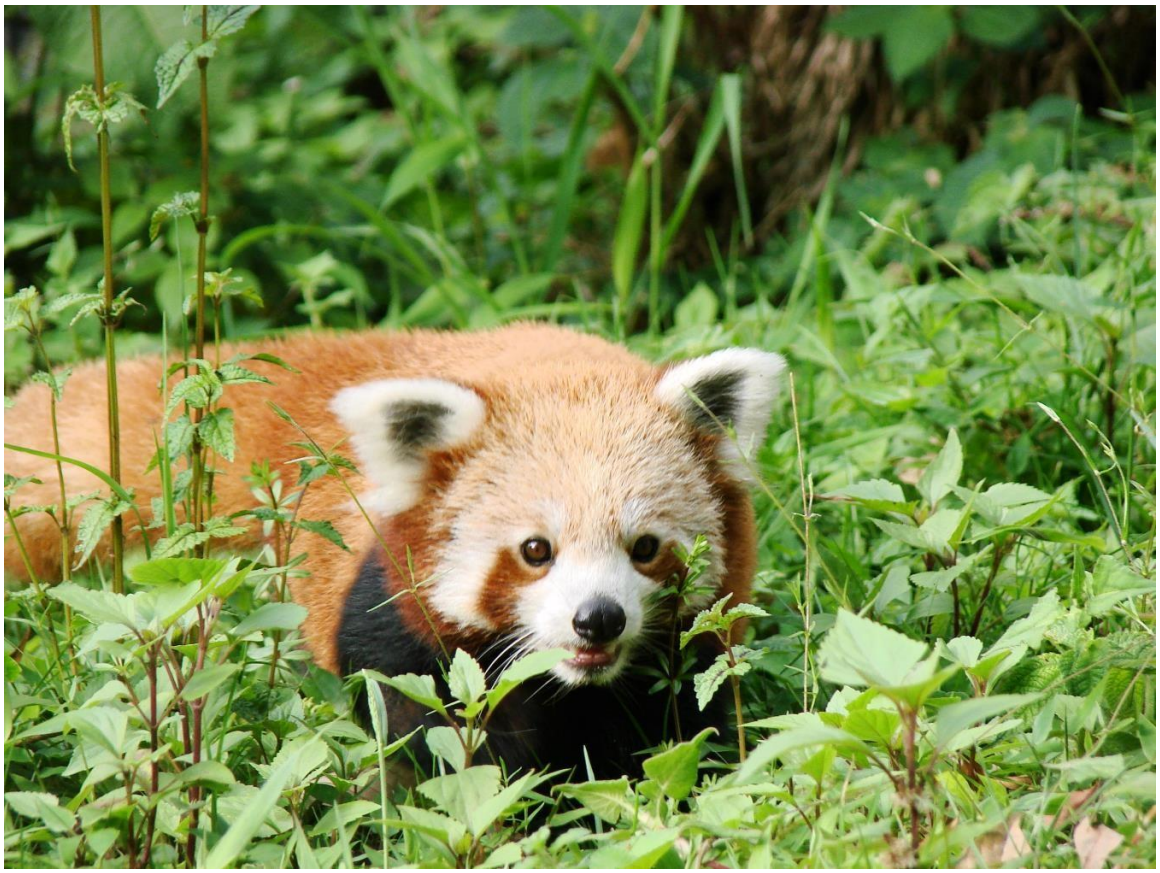


Plate 86: Red Panda at Padmaja Naidu Himalayan Zoological Park

Red pandas were the first animals to be called Pandas and considered a part of the bear family. However, now they are the only members of the Ailuridae family, which makes them a group of special interest to zoologists. The Red panda is a small arboreal mammal that is native to the eastern Himalayas and parts of South-western China. There are two known subspecies of red panda, viz. *Ailurus fulgen fulgens* and *Ailurus fulgens styani,* while the first subspecies is found in the Himalayas the latter is distributed in South and Central China. They lead an arboreal lifestyle and they prefer to live in broad-leaf deciduous and subalpine forests. Although red panda is included under the order Carnivora, its diet primarily consists of bamboo shoots and leaves.

Red pandas have striking red coats and usually reddish brown tear marks are present from the eyes to the corner of the mouth. The colour of the coat becomes more prominent during the winters when it takes a reddish tinge and thickens. They grow up to a length of around 55-63 cm and their tail is about 47 cm long. On an average the males weigh 6.2 kg and the females weigh somewhere around 6 kg. They have long and soft reddish-brown fur on the upper parts of their body and the fur is dark black on the lower side. The face is light with tear markings, upright pointed ears, black nose and pitch black eyes. The legs are black with thick fur on the soles of the paws that allows movement over thick snow. The red panda is a bamboo feeder and it has strong, curved semi-retractile claws. The head is rounded, rostrum shortened, ears are pointy large and erect. The tail is not prehensile and has 12 alternate red and buff coloured rings on it. The body is covered with long, coarse guard hairs with a woolly undercoat.

Table 17 Morphometry of Red panda

Body mass	3.7-6.2 kg (Male), 4.2-6.0 kg (Female)
Head-body length	560-625mm
Tail length	370-472mm

Life Cycle

The Red panda become sexually mature at the age of 18 months. The mating season is in winter, this is the time when solitary individuals seek out mates and copulate. The mating takes place on the ground and after a gestation period of about 134 days the neonates are born. The new-borns are blind for the first 18 days and for the first year of their life they remain with their mothers.

Table 18 Life history traits of Red panda

Life span	8-10 years wild
Mating Season	January-February
Estrus cycle	26-44 days , estrus duration 1-14 days
Age at First Birth	NA
Litter Size	1-4
Inter-birth interval	365 days
Weaning period	90 days
Weight at birth	110-130 gm

Behaviour and Social Organization

They are solitary creatures and show a crepuscular activity pattern. The animal moves with a slow cross extension gait. It usually trots when moving faster. The long tail is used for balance while moving from one tree to the other. The animals descend from the trees headfirst. They exhibit auto-grooming behaviours like licking the body, limbs and wash their face with the paw. The even rub and scratch their bodies against rocks and tree stumps.

The activity pattern of the animal in captivity changes drastically as a response to temperature, feeding regimes and in the presence of young. The animals primarily forage on the ground but are scansorial in nature. The animals can sleep on trees by straddling the branches or by curling up with the head tucked between the hind legs. The sleeping posture is determined by the ambient temperature. Mother and infants are frequently seen sleeping in close proximity to one another.

Some of the most commonly seen comfort behaviours seen in the animal includes face washing by one paw, self-licking, stretching and rubbing the back or the abdomen. Scent-marking is done by the deposition of urine, faeces and secretions of the anal and circum-anal glands; males are known to mark with more frequency than females. They use visual displays to interact with conspecifics. The intraspecific interactions include arching of the tail and the back and emitting huffing and puffing noises from a lowered head. Sometime the animal might take a bipedal posture to intimidate the opponent. Staring is one of the most commonly used aggressive behaviour that occurs in case the distances between individuals is more. Other than the aggressive behaviours the red pandas also display olfactory examination behaviour towards conspecific, which include naso-naso, naso-face, naso-torso, naso-flank, as well as naso-anal contact.

Food and Feeding Behaviour

The preferred food is young bamboo leaves in Singalila National Park, India. The leaves of *A. maling* and A. *arisata* formed the primary food items for the red panda as well as fruits of *A. strigosa* and bamboo shoots in the temperate zone. They are also reported to feed on fruits, shoots, succulent grasses, acorns, bird eggs, insects and grubs. On an average, an adult can feed on 200,000 bamboo leaves in a single day. The Red panda is the only non-primate that can taste artificial sweeteners like aspartame.

The animal eats by grabbing food items with a single forepaw and bringing it back to the mouth. The plant matters are inserted on the side of the mouth. The food items are sheared and chewed extensively before being swallowed.

Reproductive Behaviour

The frequency of scent-markings increases during the mating season and the female invites the male to mount. Copulation takes place on the ground. Males and females mate with multiple partners during the mating season. At the onset of the mating season, the

males and females rest and move in close proximity to one another. Female pre-copulatory behaviour includes frequent scent marking and tail flicking. Copulation last 3-39 minutes and the males might lick the necks and shoulders of the female; there is however no neck biting involved.

Minimum Welfare Requirements of the Species in Captivity Findings from Literature Review

Eriksson and others in 2010 did a comparative study on the existing husbandry practices of Red Panda in the zoos all over the world. The findings from these studies were used to develop recommendations on enclosure characteristics of red panda.

Enclosure Size: Field studies have established that the estimated home range of Red Panda in wild is 980m^2 – 3,300m^2. Based on this Glatston in 1989 proposed that the minimum size of a red panda enclosure should be 80m^2 for a single animal. However; since a small enclosure requires more enrichment features like nest boxes, resting places and feeding stations and the animals housed have to cope with public disturbance to a greater degree. It is therefore suggested to have a large enclosure with optimum opportunities for the animal to cope with captivity.

Social Grouping: Tennessen in 1989, suggested that enclosure space along with social environment with groups, population size and stocking density is important for successive management. A study on reproductive success of red pandas in different constellations like monogamy, polygamy and polyandry revealed that females living in a polyandrous constellation have the least reproductive success, as females in polyandrous constellation had higher amount of estradiol metabolites. Similar studies also found that polygamy reduces reproductive success of captive specimens. It was also found that home ranges of the species overlap in the wild irrespective of their genders, which means that the animals are to an extent tolerant of each other.

Enclosure space in absence of appropriate social structure of the animals housed may therefore be inadequate in ensuring their welfare.

Outside Disturbance: Glatston in 1989 suggested that Red Panda enclosures should be at least 50m away from that of large carnivores and visitor access should be restricted to one or two sides of the enclosure. Studies on captive animals have revealed that feeling the loss of control is one of the major stressors for captive animals therefore in captivity animals can't influence the outcome of most situations and thus develop a learned hopelessness. Studies found that Red Pandas only selected areas with good canopy cover for resting and activity. A complex environment with novelty will thus help the animals feel in control.

Vegetation: The vegetation inside the red panda enclosure plays a very important role in determining animal welfare. A naturalistic environment elicits natural behaviour so there should be ample trees in the enclosure where the animals can climb forage and show natural behaviours. In the wild red pandas are often seen utilizing microhabitats like fallen logs and tress stumps. The animals walk on fallen logs and tree stumps to gain access to bamboo. In this regard, PNHZP provide ample opportunities for the animals to show their natural behaviour. However one should remember that proper placement of the tree stumps and logs is important to maintain the novelty of the enclosure. At PNHZP the logs positioning is changed every few months to increase the complexity of the environment.

Water Bodies: Red pandas are good swimmers yet, none of the enclosures have water bodies for the animals. Pradhan and co-workers (2001) discovered more than 79% of animal sites in close proximity to water. Researchers are of the opinion that they seldom stay more than 250m away from water. Thus water bodies should be incorporated in the enclosure design. Heating systems should be installed in the retiring cells so that the animals are provided with a range of temperature gradients.

Climbing Structures: Red pandas are arboreal mammals and spend most of their daily activity periods on perches. Therefore it is imperative that the enclosure should have good amount of interconnected vertical structures for the animal to show its natural behaviour. Studies of captive animals have revealed that the highest climbing structure in the enclosure should have a minimum height of 4m.

Table 19 CZA Guidelines for housing Red Panda

Bears/Civets/ Lesser cats	U-shaped/V-shaped dry moats on the visitor side	U-shaped/ V-shaped dry moats or high smooth walls, or chain link fence of 4m height with 1m steel plate inclined inward	The steel plate should be placed at an angle of 60^0

Plate 87: Enclosure at Padmaja Naidu Himalayan Zoological Park, Darjeeling

Findings from Enclosure Evaluation

Existing Enclosure Condition at PNHZP Enclosure

The Janaki enclosure was one of the most natural enclosures at PNHZP. A malefemale pair was housed in this enclosure of dimensions 8.9mx2.25mx2.18m. The enclosure had 20-25 full grown trees that add to the natural look of the enclosure. This enclosure housed two animals (1:1:0:2) Janaki and Siddharth. This enclosure had a visual barrier running through the middle that provided withdrawal area from public and enclosure mate and camouflaged the nest boxes. The trees in the enclosure were taller than 4m and provide adequate opportunities for the animals to show arboreal behaviour. The arboreal pathways were well designed and connected all the perches of the enclosure. Feed was usually provided at the proximal left side of the enclosure and the animals were mostly fed at early morning and late afternoon.

Based on the enclosure assessments and behavioural assessments certain inferences can be made about the present husbandry practices of Red Panda in Indian Zoos. The inferences thus drawn have been classified as follows:

Visitor Viewing Area:

The PNHZP enclosures were smaller than HZP but they manage to furnish sufficient withdrawal areas to the animals. The viewing area at PNHZP looked artificial and the visitor disturbance levels were also higher but the animals still spent most of their time on perches as the viewing gallery was restricted to the proximal area. The animal activity near the viewer's deck was minimal for both the enclosures. At PNHZP the red pandas seldom came to the proximal part of the enclosure and choose to stay at the rear end of the perches.

Paddock Area Characteristics on Red Pandas

1. **Enclosure Barrier:** The enclosure barrier at PNHZP Pokhraj enclosure did not ensure adequate distance between the visitors and the animals; as a consequence the level of activity at the proximal part of the enclosure was minimal throughout the day and the animal spent almost all of its time behind the visual barrier.

2. **Substrate Type:** The enclosure substrate was mostly natural in all three enclosures.

3. **Enclosure Topography:** The PNHZP enclosures have undulating topography offering adequate withdrawal areas to the animals.

4. **Shelter:** The number of shelters available for use by animals at PNHZP was more than the number of animals; however, the number of arboreal perches and nest boxes is inadequate.

5. **Withdrawal Areas:** The number of withdrawal areas offered at PNHZP is significantly higher than HZP enclosure. This is primarily because of the visual barrier present at the middle in each of these enclosures.

Vegetation Features

The enclosures at PNHZP had several trees and appropriate vegetation structure that ensured availability of arboreal perches for the animals housed. These perches on trees were connected to each other by arboreal pathways that allowed unrestricted movement of animals.

Red pandas often use trees to escape from predators. In the captive environment, the trees can afford the opportunity for the animals to withdraw from visitor disturbance.

Retiring Area

Retiring cells should be designed to meet the specific requirements of each species. Inadequacies in the retiring house can often manifest itself into behavioural and physiological abnormalities of the animals. The retiring and feeding areas did not meet the species specific requirements and most of the aggressive encounters were encountered at the entrance of the shared retiring cell. Scent-marking events were also observed near the retiring cells.

Socio-Ecology and Behaviour of Animals

The enclosures housed heterosexual pairs of animals at PNHZP. There were limited aggressive encounters between enclosure mates; however, males housed in adjacent enclosures showed frequent aggressive exchanges.

Findings from Existing Enrichment Program

The red panda exhibit at Padmaja Naidu Himalayan Zoological Park provides a natural environment to the animals. The physical attributes of the enclosure was evaluated during May, 2012 and again in December 2013. Some of the revelations from the enclosure complexity scoring and the behaviour repertoire of the animals indicated that the animal welfare might be compromised on certain attributes. However, some of the behavioural patterns showed by the animals were a matter of concern. While the enclosure provided a near natural captive environment for the animals, it lacked novelty. Despite having a good stratification, the red pandas did not utilize most of the perches and chose to move on the ground. Most of the enrichments were old and did not elicit species-typical behaviour pattern. The animals did not utilize all parts of the paddock area and showed high preference for distal zones. Following enrichments were considered for developing an enrichment program to encourage a more speciestypical behaviour repertoire.

Enrichment Options for Red Pandas

Red Pandas are arboreal animals that need a behaviourally and physiologically stimulating environment to function properly in captivity. Enrichment interventions should be planned and implemented in a systematic manner following tested protocols.

Some of the essential enrichment devices for red panda have been discussed below.

Arboreal Foraging Box: In wilderness Red pandas come down from their arboreal perches to consume bamboo leaves; however, other parts of the diet is consumed from the arboreal perches. Food items with low calorie content can be kept in small arboreal foraging boxes. The arboreal foraging boxes should be small in dimensions. They should be made of natural substances like jute or cane and holes should be big enough to allow the animals to use their paws for reaching food items placed inside.

Arboreal Pathways: They are an arboreal species spending most of their time walking on horizontal branches of trees. Therefore the enclosures should have multiple interconnected, arboreal pathways. Interconnection of arboreal pathways increases the novelty of the enclosure and the animal can spend time exploring its environment. Complementing the arboreal pathways with feeding enrichment (hiding treats at different locations of the enclosure) can be beneficial to the animals.

Trees with Canopy Cover: Arboreal animals such as red panda prefer areas with good canopy cover to perform various activities. Thus providing good canopy cover in

underutilized areas of the enclosure will be a good way to increase activities in the particular area.

Water Pools: As mentioned earlier red pandas are good swimmers and prefer to stay close to water bodies. The water should be changed regularly and kept clean from leaf litter. The slope to the water pool should be gradual and the depth should not be more than 0.5m at the deepest part. The water pool should have multiple access points so that there is no point of conflict between enclosure mates.

Plate 88: Red Panda using water feature at an enclosure at Chester Zoo

Feeding Enrichment: A specialist like red panda has unique dietary needs. While dietary content plays a major role in determining the welfare of the animal, food presentation is of paramount importance. The feed provided to the animals should be presented as naturally as possible. The feeding devices should not be made of artificial substances. Bamboo leaves form the major dietary component of the animals, however one should not ignore its affiliation to the Order Carnivora. Thus animal protein should also be included in the diet of the animal.

Nest Boxes on Perches: All the studied enclosures had nest boxes in them which were placed on the ground or at an elevation of less than 2m. Nest boxes provided on

Plate 89: Arboreal nest boxes for red pandas

perches can provide vantage point to the animal and impart a sense of security to the animals. The nest box should be strong enough to support the weight of the animal and secured to branches. The nest box should have two exits so that animals do not get cornered. The base of the nest box should have wood wool or small branches. The nest boxes should be covered to protect the animals from inclement weather.

Testing the Efficacy of Enrichment Devices and their Combinations

Enrichment Devices Implemented

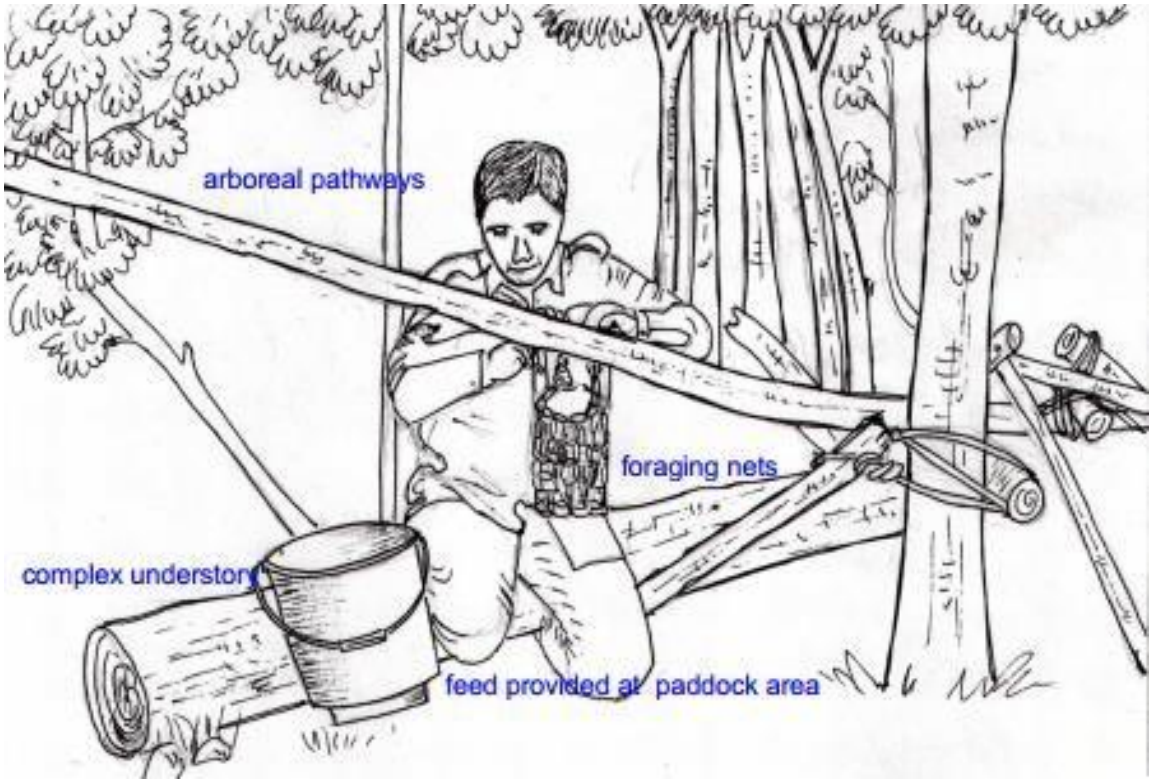


Plate 90: Zookeeper setting up enrichments at a red panda enclosure

Feeding Enrichments

1. Arboreal nets: The nets were made from coir ropes and hung from low lying branches in the enclosure. The nets had small openings that the animal could tease apart to extract fruits and forage upon them. After the animals were sensitized to the feeding enrichment device, leaves were added to increase the complexity of the enrichment item.

Plate 9: Arboreal net feeders

Findings

a. Arboreal nets were made with coir ropes that are natural and do not pose any risk to the animals.

b. The nets were made with gaps that were smaller than the paw of the red panda. This was done to ensure that the animal never had its paws entangled in the nets.

c. The arboreal nets were never placed above 1m from the ground, and always placed near a platform, to prevent accidents.

d. The food (apple slices) were placed inside the net and leaves were placed around the nets, so that the animals had to use their dexterity and cognitive abilities to take out the food items.

e. We found that the arboreal nets were highly successful in increasing the foraging behaviour.

2. Foraging Boxes:

Foraging boxes consisted of cane baskets placed at perches near the proximal part of the enclosure that were filled with fruits and bamboo leaves that the animals could

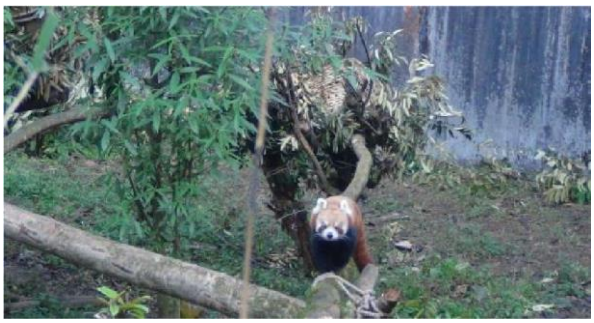


Plate 92: Arboreal foraging boxes for red pandas

forage upon. The foraging boxes were spread wide apart so that a single animal could not monopolize all resources and therefore all animals had equal foraging opportunities.

Findings

a. The foraging boxes ensured that both red pandas received a good amount of food.

b. The foraging boxes provided a viable alternative to feeding the pandas in the paddock area with natural food presentation as opposed to feeding them in trays at the retiring cells.

c. Conflict over food was a common occurrence when the feed was provided at the retiring cell. This happened because, there was only one entrance to the retiring cell and only the bigger animal would monopolize food resources, leaving smaller animals in a state of stress. By providing multiple foraging boxes we ensured that all animals received equal amount of nutrition.

d. There was less conflict between animals after introducing foraging boxes.

e. The foraging boxes need to be placed far apart from one another, so that no animal can monopolize all food resources.

3. Vertically Placed Bamboo Shoots: In the wild, red pandas forage on wild bamboo which occur in vertical clumps and red pandas have to spend a lot of energy to forage on the bamboo. As a part of the enrichment schedule we placed the provisioned bamboo shoots vertically rather than horizontally.

Plate 93: Vertically placed bamboo shoots being foraged by red pandas at dusk

b. The natural food presentation mechanism required more active effort from the red panda to get food items.

Plate 94: Using arboreal pathways

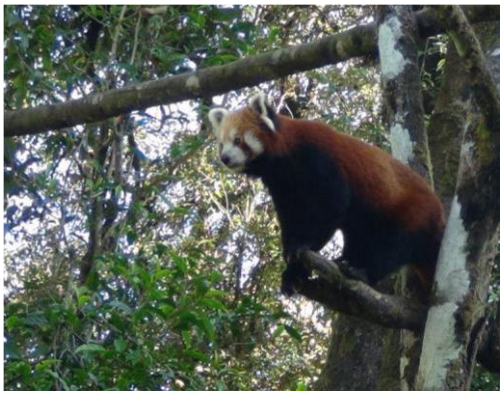
Findings

a. The vertically placed bamboo shoots look natural and promote the natural food handling behaviour.

Manipulable Enrichments

1. **Arboreal Pathways:** Until now, the enclosure had a single-tier arboreal pathway. Therefore, if one animal was walking on the arboreal path, the other animal had to choose the ground to move around. Multiple interconnected, arboreal pathways were created using bamboo poles and wooden logs with bark to increases the novelty of the enclosure so that the animal can spend time exploring its environment. The arboreal pathways should have a multi-tier design so that one animal moving along an arboreal path has a chance to escape from other animals to a lower or higher tier arboreal path.

2. **Visual Barriers:** During the pre-enrichment behaviour study we found that red pandas were spending a large amount of time staring at conspecifics in adjacent enclosures (threat display) and they were also scent marking near the boundaries of enclosures. We placed two to three visual barriers in the form of bamboo poles with bamboo shoots around them to act as a visual barrier. We grounded the bamboo poles deep into the ground and tied them to some nearby structures so that they never fall off and create an escape opportunity.



The arboreal paths should have multiple points of entry, through multiple slanted logs, trees, etc.

Findings

a. Arboreal pathways are very important for creating a complex and naturalistic habitat for red pandas.

b. The animals explored and used various areas of the enclosure through the arboreal paths.

Plate 95: Visual barriers reduce threat displays and aggression

Findings

a. Withdrawal areas were very successful and we found that the animals slowly started using the proximal portion of th eenclosure due to the presence of visual barriers.

b. The visual barriers were designed to incorporate naturalistic features such as bamboo poles, used bamboo shoots etc.

c. These visual barriers effectively curtailed the amount of negative interaction (staring and scent marking) that the animals showed towards other conspecifics in adjacent enclosures.

d. The amount of movement stereotypy shown by animals was effectively reduced due to the withdrawal areas.

3. **Arboreal Perches:** As a part of the enrichment program we created new arboreal perches for the animals and we also provided nest boxes near the top

Plate 96: Arboreal perches

canopy. The nest boxes were placed in a way so that the entrance to the nest box faced away from the visitors and provided the necessary seclusion to the animals.

Findings:

a. The arboreal perches were highly successful and we observed that red pandas preferred the higher most perches.

b. The arboreal perches were placed facing away from the visitors and the opening of the nest box faced east so that the animals could bask in the sun at dawn.

c. The arboreal perches provided enough withdrawal space for the animals

d. We placed multiple logs leading to the arboreal perches, so that the animals had alternative excape routes if attacked by a concepecific or external predator in the enclosure.

Plate 97: Complex understory

4. Complex Understory:

The floor of the enclosure was barren and free from complexity, which led animals to show fixed motion pathways through the understory. We envisaged an enclosure enrichment intervention by creating branch piles at certain locations that blocked the fixed routes of the animals. These enrichments increased the

novelty of the enclosure as the animals had to move through a different route and use cognitive skills to reach preferred locations of the enclosure.

Findings

a. The complex understory was effective in reducing stereotypic movement patterns in the red panda.

b. By blocking areas of scent marking we ensured that the cycle of stereotypic behaviour was blocked.

c. Additionally, we provided alternatives to stereotypic behaviour by scattering resources (food items) at concealed spots. Therefore the animals had something to do at the understory rather than pacing.

Table 20 Enrichment options for Red panda

Enrichment Device	Enrichment type	Materials required	Location	Species-typical behaviour targeted	Safeguards
Arboreal foraging box	Feeding enrichment	Cane baskets hung from trees, filled with fruits	Arboreal perches	Foraging	All sharp edges of the cane baskets were filed off to reduce chance of injury to the animals. The baskets were kept at a height of less than 1.5m from the ground to ensure that animals do not get their limbs caught in the orifices. The baskets were tightly secured on Y-shaped branches to provide adequate foothold for animals to manipulate the enrichment devices
Water pool	Permanent fixture	Natural water body of small dimension, maximum depth 1m	Proximal end of the enclosure	Drinking, play behaviour	The water pool could not be implemented due to logistical constraints

Wobble bamboo	Feeding and Manipulable enrichment	6m tall log with 2m underground and 4m on the surface. The bamboo pole should have bark on it and a basket of diameter 0.3m with holes on all four sides big enough to let nuts and raisins fall to the ground when the log shakes. Will need to be loaded at the beginning of the day	Medial zone	Foraging and visual barrier	Unused bamboo shoots were tied around a long bamboo pole and planted upright along the left side of the enclosure. Instead of ropes, we used bamboo shoots to tie the branches to the pole. No artificial substances were used to construct this enrichment
Upright logs	Manipulable and feeding enrichment	Four logs will be placed adjacent to each other and tied so that the animals can climb on it. Holes can		The animals can scratch against the logs, climb on them to search for food, The exploratory nature	Logs from surrounding oak trees were procured and placed on the enclosure

Enrichment Device	Enrichment type	Materials required	Location	S t b t

		be drilled on to the logs and small treats like raisins. The logs should be more than 12ft tall above the ground and an additional 4ft underground to maintain stability of the structure		of animals can be encouraged through thes upright logs
Branch piles	Manipulable and feeding enrichment	Small logs 20-30 of them of length 1m and diameter 0.6m can be used to make piles at different locations and loaded with small treats like nuts and raisins		Promotes exploratory behaviour, play behaviour et
Scratching posts	Manipulable and sensory enrichment	Single upright bamboo poles with coir ropes rubbed with dirt from other red panda enclosures		Promotes autogroomin and other behaviours such as scratching etc.
Feeding Schedule and Area	Management Practices	We propose that the fresh bamboo shoots should be provided at two different locations at the enclosure.	Food can be provided at the medial portion of the exhibit	Promotes enclosure utilization. Helps anima display more speciestypic behaviours.

Hanging treats	Feeding enrichment	Whole apples hung from a thread will increase foraging time	This enrichment will be hung from trees	I f b
Arboreal Pathway	Manipulable enrichment	Plant some bamboo stumps on the ground and connect them with each other. Arboreal	Proximal zone	I l a

Enrichment Device	Enrichment type	Materials required	Location	Species-typical behaviour targeted	Safeguards
		pathways should act as a connection between two or three arboreal perches so that the animals			branches.

Nest boxes	Manipulable and Sensory	Natural nest boxes placed at different heights of the enclosure	Proximal, median and distal zones	Reduce stress, promote natural resting behaviour	Nest boxes were checked for protruding nails and wood chips.

Table 21 Efficacy of enrichment intervention at Red panda enclosure

Pre – enrichment feature	Modified enclosure feature	Needs addressed	Efficacy of enrichment post enrichment study
Lack of novelty in the enclosure environment	New enrichment devices implemented	Boredom and lack of opportunity to perform instinctive behaviour mitigated	The animals started showing diverse behaviour repertoire
Proximal and medial zones underutilized	All enclosure zones were provided with feeding and sensory enrichments	The animals could now forage and move through the enclosure in search for treats	The daily movement of the animals increased. All enclosure zones equally utilized
Animals show a high preference for distal areas	Enrichments were placed at distal, median and the proximal zone	Animals had to move through all parts of the enclosure to use enrichment devices	
Arboreal red pandas were spending more time on the ground than on perches	Feeding and sensory enrichments were placed on perches	Although the enclosure had a good amount of stratification. The ground strata was more enriched than the arboreal areas. Postenrichment, complexity of all enclosure zones increased, therefore animals could exercise their choice and they shifted to a	The red pandas depicted a more species-specific behaviour repertoire

		more natural arboreal lifestyle	

Summary of Recommendations

To summarize we can draw the following conclusions from our observations

1. Enrichments and scientific management practices effectively reduced the level of aberrant repetitive behaviours in red pandas studied.
2. Food was the biggest motivation for the study subjects and therefore all enrichments were designed based on a reward-based positive reinforcement approach to make the animals spend more energy to get miniscule food rewards.
3. The enrichment plan worked perfectly for the first few days, but red pandas being intelligent at problem solving started to notice the pattern. So we constantly changed the locations of certain preferred food items across the enclosure. Therefore making sure that the animals had to visit all the possible foraging sites in order to get their choice of food items. Thereby we ensured that the novelty and complexity of the enclosure was maintained throughout the study period.
4. At each of the foraging boxes, we put a mix of foods with high processing time and low processing time. This ensured that the animals could not move through all the enrichment items very fast. The complexity of the food items forced the animals to spend significant amount of time on each enrichment.

Mega-Herbivores: Essential Environmental Enrichments for Asian Elephant

5. Enrichment interventions should not lead to undue stress and aggression between conspecifics.

Problem identification is a very important step that should precede every enrichment intervention.

Animal Biology and Behavioural Ecology

The three large-bodied species *viz* Asian Elephant, Gaur and One-horned Indian Rhinoceros are grouped as mega-herbivores. Each of the species has its unique biology and behaviour that determine its habitat requirements. Asian elephant and Gaur are social animals living in herds led by matriarchs while Rhinoceros are solitary in nature tolerating the presence of con-specifics at close quarters. The species are bulk feeders, with rhinoceros and gaur maintaining smaller home ranges while elephants range over much larger forest tracts. For determining critical housing needs for mega-herbivores in captivity, Asian elephants were used as the type species due to the larger overlap in habitat requirements and behavioural ecology that the species has with both the other species.

The Asian elephant is the largest land mammal found in India, an adult bull weighs up to 3,000 kg and they can have a shoulder height of 245-275 cm. These animals are the only living species of the genus *Elephas* and they are found in India, Bhutan, Nepal, Srilanka, Myanmar, China, Cambodia and other countries of southeast Asia.
There are 3 known subspecies of the Asian elephant.

1. *Elephas maximus maximus:* Srilanka
2. *Elephas maximus indicus:* Mainland Asia
3. *Elephas maximus sumatranus:* Sumatra

Trunks are the most distinctive feature of Elephants which, gives Order Proboscidea its name. These highly sensitive prehensile organs are formed with the fusion of the nose and the upper lip. Elephants use their trunks for feeding, watering, dusting, smelling,

touching, breathing, communication, washing, pinching, grasping, defence and offense. Male Asian Elephants have long tusks; that are used as tools for debarking, uprooting trees as well as weapons of offense and defence. The female Asian elephants however lack tusks. The skin of Asian elephant is a shade of grey and heavily wrinkled with multiple layers. The average body temperature for Asian elephants is 35.9^{o}C.

Table 22 Life history traits of Asian elephant

Life span	60 years in Wild and 80 in captivity
Breeding season	No seasonality, based on food availability
Estrus cycle	12-18 weeks duration
Age at first birth	11-14 years (females),15 (males)
Gestation period	540-660 days
Mating system	Polygynous
Litter size	1
Interbirth interval	3-4 years
Parental care	Mothers care for their young ones. However all herd members take equal responsibility for the young ones.

Habitat and Ecology

Asian elephants are generalists and inhabit grasslands of tropical evergreen forests, semi-evergreen forest, moist deciduous forest, dry deciduous forest and dry thorn forests as well as cultivated and secondary forests and scrublands. In the eastern Himalayas (certain parts of north-east India) the animals frequently move above 3000m asl in summers. The large body weight of the elephant requires them to consume a huge volume of food every day. Being generalists, elephants browse and graze on a wide variety of plants. The proportion of different plants in the elephant diet varies with the habitat type and season. During the dry season, browse makes up for 70% of the daily food requirement, while during the wet season grasses constitute 55% of the daily food intake. Forest type may also play a role in food selection of elephants; browse formed 15% of the diet in a dry deciduous forest and 47% in a thorn forest during the dry season. The annual diet was dominated by grass (84%).

Behaviour

Elephants are intelligent and highly social animals, showing a varied range of behavioural patterns and social gestures. They live in herds led by the matriarch while the adult males

remain solitary or may form bachelor herds. While moving the adult herd members provide constant protection to the young ones and do not let them stray. The extensive generation overlap in the elephant community leads to linear dominance hierarchy among the females. The group leaders always walk at the front or the rear protecting the herd from predators. Bulls usually travel in the periphery. Sometimes, lactating cows with attendant young might aggregate together to form nursery units. The male elephants stay with the family unit till the age of 15 and have strong social ties with the mother and siblings. The home ranges of herds can vary between 180600 km^2. The same area can be used by herds of elephants that are related. The herds move separately and maintain their kinship via vocal communication.

In the wild when one elephant approaches another, they do so with their trunks extended. The first few minutes of encounter among two elephants involve mutual examination of ear, mouth, feet, eyes, temporal glands, anus and genitalia.

Food and Feeding Behaviour

Asian elephants are generalist herbivores consuming a wide variety of plants (100 different plant species). The ratio of grasses to browse eaten by the elephant varies seasonally and the forest type inhabited. The nutrient value of grass is at its highest in the wet season and that of browse peaks in the dry season. Although they are generalists, elephants still display a significant amount of food preference; food eaten is not necessarily the food most commonly found in the home range. Crops such as banana, sugarcane and paddy are highly preferred.

The animals usually eat early in the morning, evening and night and rest during midday. More than 150 kg of vegetation is ingested each day of which only 44% is digested with the help of gut bacteria. They eat long grasses by plucking them up with their trunk. Short grasses are picked up along with clods of earth still attached to the roots and consumed after dusting off the dirt. Elephants drink at least 140 litres of water every day.

Reproductive Behaviour

Elephants are polygynous mammals and display a high degree of sexual dimorphism, with full grown males being much larger than females. The ‘estrus walk’ shown by female elephants is an indicator that the animal is in a sexually receptive state. During this the, female elephant holds her head on one side and walks away from the group and returns making a complete arc. They are highly wary of approaching bulls during this time. Tail-flicking behaviour in which the female dabs the tip of the tail near the urogenital area and holds it up could be perceived as an advertisement of sexual receptivity.

The musth gland present in the males elephant start to secrete dark, oily, musky substance every year for a certain period once they reach sexual maturity (10-15 years). This physiologic change is followed by excitable, dominant and overtly aggressive

behaviour. The musth period can last from a few days to several months and the bulls can become uncontrollable during this time. There is no seasonal pattern of musth and different individuals exhibit it at different times of the year.

Minimum Welfare Requirements of the Species in Captivity

Ensuring the welfare of elephants in captivity has always posed a challenge for zoo managers. According to the report on the elephant task force, MoEF 2010, there are about 3500 elephants in captivity across the country however only 139 elephants have been reported to CZA as of the latest inventory report of the CZA website. Out of these 139 elephants 67 are owned by 19 circuses and the remaining are in 21 zoos and rescue centers around the country.

Findings from Literature Review

Each species of mega-herbivore has its unique basic requirements which need to be considered. However, for mega-herbivore as a whole the following points are to be considered:

1. **Proper Social Grouping:** A proper social grouping in captivity is considered the best form of enrichment for social animals. Being highly social animals' elephants and gaur need to be housed with con-specifics; male with one or more females being the preferred social structure. Rhinoceros on the other hand may be maintained solitary.

2. **Enclosure Aspect:** Temperature and settings of an enclosure are to be maintained according to the geographical and climatic condition of the zoo location. They should ensure adequate basking and sheltered areas are available to all the animals of the enclosure.

3. **Space:** Space provision should be made such that the animal can move around freely and exhibit at-least a part of its natural behaviour repertoire. The minimum space standards for exhibit and retiring areas differ from one country to another.

4. **Food and Nutrition:** The species are bulk-feeders they need to be provided with a large quantity of green fodder/browse of poor quality to keep their appetites sated. Concentrates should be provided for supplementing nutrient shortages in the diets provided and should include necessary mineral and vitamin supplements. Feed should be provided according to individual needs (age, sex, health condition, etc. of the individual) in a manner that prolongs feeding time.

5. **Sanitation and Hygiene:** Health and hygiene of the animals should not be compromised. The enclosures should be cleaned frequently and care need to be taken that they are rodent proof. Health of the animals should be checked regularly.

6. **Keeper and Animal Interaction:** Multiple animal keepers with genuine interest for the animal's wellbeing are to be engaged.

Findings from Enclosure Evaluation

The enclosure evaluation of Asian Elephant was done at National Zoological Park, New Delhi, Alipore Zoological Garden, Kolkata and Mahendra Chaudhary Zoological Park, Chatbir. The following are some of the findings after the evaluation -

1. **Barren or Monotonous Exhibit Area:** The enclosures showed a lack of appropriate vegetation and enrichment devices. Vegetation though present, was often not species specific and had poor stratification. Enrichment devices where present, were not changed leading to poor use by the animals and reduce the aesthetics of the exhibit area.
2. **Ill-Managed Social Groups:** Only females were present in two out of the three enclosures. Males when present were often found chained inside retiring area.
3. **Predictable and Routine way of Food Presentation:** Feed is always given at the same location and time in almost all the zoos. Behavioural abnormalities in the animals often increase as the feeding time approaches.
4. **Small Exhibit and Retiring Area:** Space provided for the elephants was limited in almost all the enclosures. This limits the freedom of movement of animals and constrains them to small spaces.
5. **Unequal Space Utilization of the Exhibit Area:** Animals were often found using only some parts of enclosure usually those; that were close to water source, shed and least disturbed by the visitors.
6. **Limited Activity:** As a result of lack of stimuli and novelty in the environment most of the animals were found resting during the day with predictable activity patterns.
7. **Inappropriate Substrates:** Most of the elephants had to spend on standing on concrete substrate chained for almost 16-17 hours a day in a short chain hooked in one place. Males during musth were chained inside throughout the period.

Evaluation of Mahendra Chaudhary Zoological Park Elephant Enclosure

Mahendra Chaudhary Zoological Park elephant enclosure spans across 1.5 ha and is home to four adult female elephants and a male calf. The area accommodates all the animals comfortably

1. Visitor Viewing Area

The viewing area was continuous and 2/3 of the enclosure could be used as viewing gallery. During peak hour crowding occurs around the enclosure. The visibility level was as high as 100%.

Plate 98: Mahendra Chaudhary Zoological Park elephant enclosure

with equal opportunities for all animals to utilize most portions of the exhibit.

Plate 99: Viewing area/ viewing gallery

2. Paddock Area Characteristics

The paddock was level ground with shade available only in the retiring area/shed. A large dried pucca water pool was present in the middle of the enclosure and water was available only at one point at the distal corner.

Plate 100: Paddock area

3.

Vegetation was present inside the enclosure however, not to according to the need of the animal. The enclosure had just lush green lawn of grasses and a couple of palm trees No shade trees were present in the enclosure.

Enclosure Enrichments

Few enrichments in the form of wooden logs either standing upright or lying were inside the enclosure; they were however, hardly used by the animal.

4. Vegetation Features

5. Retiring Area A common retiring area was attached to the enclosure and was visible to the public. It was concrete floored, barren and open, without any enrichment except for the loops for the chains to tie the animals during the off-display hour. There was no off-display day kraal for this enclosure.

Plate 101: Retiring area/shed

6. Socio-ecology and Behaviour

No aberrant behaviour could be observed in any of the animals except for short duration of head swaying or bobbing while inside the retiring area. Extensive social interactions were observed between the animals however, they were mostly found concentrated inside or near the retiring area/shed.

7. Nutrition and Feeding

The animals were provided feed twice a day inside the retiring area. Concentrate feed was provided in the morning after the animals were released and green fodder, just before the animals were taken inside. There was only one drinking point inside the enclosure which was accessible to the animals only during the display hours.

Plate 102: Animals were found concentrated near the retiring area most of the time

Plate 103: Feed were provided twice daily inside the shed

Table 23 Enrichment options for Asian elephant

	Enrichment Types		Species-typical behaviour targeted
1.	Feeding Enrichment	Browse feeder	Increase activity & foraging time
		Scatter feed	-do-
		Pot feeder	-do-

		Logs with bark	Help in the animal's agility and fine motor skills
		Grass bales/Hessian bags	Increase activity & foraging time
2.	**Sensory Enrichment**	Coir ropes on logs	Elicit behaviour such as scratching on the logs
		Dust baths	Keep ecto-parasite in check and would also elicit some natural behaviour
		Water-pool	Elicit play behaviour
		Spices spray	Elicit locomotion
		Logs with bark	Increase play as well as feeding behaviour
		Shade/Temporary shed	Change movement pattern
3.	**Manipulable Enrichment**	Log piles	Increase play as well as feeding behaviour
		Log tree	Elicit behaviour such as scratching and leaning on it
		Grass bales/Hessian bags	Increase play behaviour Increase feeding time
4.	**Environment Enrichment**	Temporary shed	Increase space use
		Water in pool	Increase activity such as play, bath, locomotion, etc.

Testing the Efficacy of Enrichments Introduced

Browse Feeder: To provide a place where the animals could feed by browsing.

The browse feeder was made of horizontally rod iron compartment of about 1.5m x 1mx 0.3m in dimension with lid on top and latch at the rear end. It has two small openings in front from which the animal can reach for feed with some difficulty. It was placed on the wall at a height of 8 meter at the distal part of the enclosure. Care was taken that the feeder stay intact on the wall by providing support at the back and middle using iron poles and cement. Green fodder (Sorghum) and few fruits were put inside the feeder every day during the study period.

Plate 104: Browse feeder setup

Findings:

Plate 105: Elephants interacting and feeding from the browse feeder

a. The browse feeder was one of the most favoured enrichment devices for the animals. The animals are often found interacting with it for most part of the display period.

b. Browse feeder could be made of other more naturalistic looking material as long as it can withstand the wear and tear cause by elephants.

c. It is not necessary that a wall should be used to hold the feeder. Other means of elevating the feeder such as constructing platform made of wood or concrete, etc. could be done.

d. There should be at least more than one such feeder inside the enclosure.

Scatter Feed: To scatter green fodder and fruits

Green fodders were tied together in small bunch and scattered around the enclosures.
Fruits were also used for scatter feeding.

Findings:

a. Help to motivate the animals to move around more and increase their activity level.

b. Increase the foraging time as well.

Pot Feeder: A feeding device to keep the animals occupied

A coloured camouflaged metal pot was used as a feeder where the elephant could reach in through pot's mouth with its trunk and suck out few pieces of feed item provided. It was placed at two elevated points at a height of about 10 meter with the help of jute and coir ropes. Soaked Bengal gram and fruits mixed with grasses were used as feed.

Plate 106: Setting up of pot feeder

Plate 107: Interaction with the pot feeder held up on a tree log

gs: Findings:

a. Instant response was observed with the introduction of log piles. The calf especially was observed interacting with the logs, lifting, nudging and carrying most of the time.

b. Providingogs with bark provided a motivation to the animals to deliberately coordinate their trunk movement requiring dexterity and skill.

c. Easiest and safest means of enrichment for elephant.

phants were often found inte ix
ide and also tried to pull the e
ed to be taken to check the ep
he paddock area.

Presence of metal pot acted as
sunny days. The metal get heate
ma

Barked Logs /Log Pile: A means of feed as well as manipulable enrichment. Tree logs with bark from the surrounding area inside the zoo were gathered and placed in a pile as well as scattered at few places inside the enclosure. This provided opportunity to the animal to spend time to debark the logs with their feet and trunk or simply play with the logs around the enclosure.

Plate 108: Log pile on one side of the enclosure

Plate 109: Elephants interacting with the log and feeding on its bark

Grass Bale/Hessian Bag: A new way of feed presentation

Plate 110: Step by step procedure of making grass bales

Grasses gathered from the surrounding area were used in this case. There were two ways of presenting these grasses to the elephants. One was to roll the grasses in layers into neat bundle by tying it up with ropes/rope nets while inserting some fruits inside. Another was to compactly fill hessian bag with grasses and few fruits after which the mouth of the bag was sewed.

Findings:

a. The grass bales were a novel and fun way of providing feed to the animals. Animals were observed interacting with them for a good period of time.

b. Animals were observed feeding, tossing and turning the bales with trunk and on some occasion, limbs.

c. Different sizes and shapes of bales could also be introduced.

d. Hiding of fruits inside or scenting the bales with fruity smell entices the animals to interact more.

Plate 111: Elephants interacting with grass bales

Plate 112: Interaction with grass and fruits filled Hessian bag

a. After the coir ropes were wound around the logs, the animal started interacting with them.

b. The logs were not observed used as scratching post as expected. The animals were mostly observed trying the peel the ropes out and play with them.

Coir Ropes on Logs: To provide a new covering on logs

There were upright logs inside the enclosure which the animals were not using. Coir ropes were tied around these kinds of logs to increase activity of the animal by using them as a rubbing post, play things, and so forth.

Plate 113: Coir ropes worn around log

Findings:

c. Addition of some new material on the old structure revived the interest of the animals.

Plate 114: Interaction with log tied with coir rope

Dust Bath: To provide loose soil for the animals

Dug out soil inside the enclosure at different location especially for constructing new shed was used for this purpose. Compact soils had to be loosened by digging once in two days.

Findings:

a. The animals were often observed throwing dust on their back.

b. Presence of loosen soil made the animals to perform dust bath more often.

Temporary Shed: To provide an alternate shade and resting area

The temporary shed of 30 x 40 m^2 area with a height of about 20 m were put up at the distal part of the enclosure. Straight and sturdy logs were used as pillars at four corners and agro-net was used as the roof of the shed. It took heavy machineries and a lot of man power and about a week's time to complete the construction.

Plate 115: Step-wise set up procedure for temporary shed

Findings:

a. The animal started to use the shed frequently and this allowed an alternate place and choice of shade and shelter.

b. This shed was constructed in the most easiest and fast manner. More robust and permanent alternate area of shades and shelter could be constructed.

Plate 116: Temporary shed

Plate 117: Elephants interacting with various enrichments provided inside the enclosure

Summary

The enrichment of elephant enclosure at Mahendra Chaudhary Zoological Park showed the possibilities and difficulties of planning, executing and assessing various ideas of enrichment on ground. Elephant being a massive animal, fabricating enrichment devices or any other often take considerable amount of time and manpower. It took around 15-20

men every day for 10 days and heavy machinery such as crane, JCB and tractors to set up the enrichments inside the enclosure. All the enrichments for our study were based on the immediate requirements of the animals, practicality of the plan and logistic availability. As the result indicated there is definitely a positive change in the behaviour and space use pattern of the elephants in the enclosure. The extent of changes occurred and robustness of the enrichment items used has also been discussed.

The individual requirement of each elephant has not been taken into consideration in this study however, for a holistic planning and study this needs to be addressed. Each animal has its unique personality and requirements. This said, the social dynamic of the animals in the herd should not be undermined since social enrichment is considered the most important enrichment for such highly intelligent and social animal.

The following points sum up our observation made during our study:

1. Enrichment intervention in elephant enclosure can effectively increase activity level and space utilization pattern.
2. Problem identification is a very important step that should precede every enrichment intervention.
3. Enrichments that provide food reward work best and are the biggest motivation for the animals; however, individual preferences need to be considered though herd requirement is also important.
4. Enrichments provide opportunity to the elephants to strengthen their social bonding. It was observed that a female that stayed away from the group most of the time started spending more time with the group after the enrichment intervention.
5. Elephants being intelligent animal can easily pick up cues and patterns of enrichment works, in a short time. To keep up with this, enrichment plan need to be constantly changed and be open to improving or improvising.
6. Enrichment devices and strategies need to be presented on a varied schedule and in a variety of context to make sure the animals do not become desensitized or habituated to them.
7. A difficulty while constructing elephant enrichment devices is ensuring that the devices withstand the elephants at least for some days while using construction material that is natural and aesthetic looking.
8. Presence of enough enthusiastic animal care staff is essential for a successful enrichment plan since they are the one who has to look after the enclosure and continue taking care of the animals.

Ungulates: Essential Environmental Enrichments for Brow-antlered Deer

Chapter 9

Animal Biology and Behavioural Ecology

Ungulates include terrestrial hoofed herbivore mammals. They are an important constituent of most terrestrial ecosystems utilizing the primary productivity of plants and making it available for the carnivorous mammals. *Ruervus eldii eldii* or the Eld's deer or the Sangai is a highly endangered species of deer. Commonly *R. e. eldii* is referred as the Manipur brow-antlered deer or the Sangai. The population of Sangai is localised in the marshy wetlands of the Keibul Lamjao around 45km from Imphal. The biggest population of the Sangai deer is found near the Loktak Lake (largest freshwater lake of eastern India). Sangai is the state animal of Manipur.

Table 24 Life history traits of Sangai

Age of Sexual Maturity	4 years for female
Gestation period	245-273 days
Litter Size	1
Age at weaning	70-90 days
Breeding season	September-December (Peak in March)
Life span	20 years
Inter-birth Interval	1 year
Weight at birth	4.7 – 6 kg
Mating System	Polygynous

Behaviour and Social Organization

The amount of information available on the social organization of Sangai is limited; however, a close relative the Thamins are usually solitary except during spring when the animals are seen in large groups comprising of both sexes. A survey conducted in Myanmar reported a group size of 1-20 with adult male: female ratio of 1.00:1.59 and that of doe:fawn 1.00:0.54. Unlike Cervids, the brow-antlered deer shows distinct reproductive seasonality.

Food and Feeding Behaviour

As many as 233 plant species belonging to more than 58 families are fed upon by the brow-antlered deer in Keibul Lamjao National Park. Out of the 233 identified plants, 33 are known to be primary food plants and 21 are emergency food plants. The common plant species include *Zizania latifolia, Sachhrum sp., Erianthus* and *Capillipedim sp.* The foraging condition is perfect during the months of May-June, so the antlers grow the most during this period. The brow-antlered deer is known to exhibit a bi-modal activity pattern. They typically start foraging at early morning around 0430 hrs-0800 hrs. During summer they might stop feeding at 07.00hrs. The animals rest under tall reeds and grasses during most part of the day while at night, some of the animals rest on hillocks.

Reproductive Behaviour

The Sangai is a seasonal breeder and it has a polygynous mating system. The Sangai females exhibit a prolonged period of ovarian activity from 225-342 days, during this period the females average around 10-17 estrus cycles. After the mating season is over the females become sexually unreceptive or they enter “Anestrus”. During the mating season aggressive behaviour is exhibited by the males (head up display). Another common display of aggression is the rubbing of head or preorbital organ on bushes or thrashing vegetation with antlers or forelegs. The fights for dominance occur during February and March when young solitary stags challenge the holder stags. The fights are not restricted to aggressive displays; the animals almost always lock antlers. After the fight is over the winner raises its head to show its dominance while the weaker stag literally “bows” out. Mortality rates for a young or weaker stag is unusually high in captivity. So it is better to separate the males during the rutting season. The leader male gets the chance to mate with females. It assumes threat postures and invites the female for mating. When the female is ready to mate she will rub her nose against the flanks of the stag and spread her hind legs for mounting. During copulation the male stands on its hind legs and rests its forelegs on the back of the female. The act of mating takes just a few seconds. The male becomes relatively complacent after copulation.

Minimum Welfare Requirements of Sangai in Captivity

There are 15 zoos across the country that house about 172 of this critically endangered subspecies in captivity at present (CZA inventory, 2011). Since Browantlered Deer are endemic at a special habitat type found only in Manipur, creating a near natural habitat condition in captive environment is challenging. However, so far they have been breeding and propagating well in the captive conditions provided. The priority at the present scenario is to let the animals retain their natural behaviour repertoire as in the wild and be in a condition where they could be introduced in wild if such opportunity arises.

Findings from Literature Review

Each of the deer species has their unique basic requirements which need to be considered. For the deer as a whole the following points are to be considered:

1. Geographical and climatic condition of the zoo location: according to which sun and shade areas as well as the settings of the enclosure be maintained.
2. Exhibit and retiring area should be large enough for a herd to move around freely. It should also ensure that aggressive individuals can be avoided by other enclosure residents.
3. Proper social grouping appropriate for each species should be provided.
4. Feed should always be certified safe before feeding and should be fed according to individual needs (age, sex, health condition, etc. of the individual). Seasonal changes in nutritional needs should be addressed.
5. Health and hygiene of the animals should not be compromised. The enclosures should be cleaned regularly and care need to be taken that they are rodent proof. Health of the animals should be checked regularly.
6. There should be close connecting enclosures/kraals to segregate animals during rutting period. There should also be a deer crush in each enclosure.

Findings from Enclosure Evaluation

Enclosure evaluation for Brow-antlered Deer was carried out at Alipore Zoological Garden, Kolkata, Manipur Zoological Park, Imphal and National Zoological Park, Delhi. The following are the some of the findings -

1. Barren or monotonous exhibit area: Lack of vegetation and enrichments is pronounced in most ungulate enclosures assessed. In enclosures with vegetation it is often not species specific and had improper stratification. Enrichment devices were not observed in the enclosures assessed.
2. Inappropriate social groups: The group size usually was too large for the space available in most of the enclosure or else it on the other extreme of having only a few animals. Animals could not be individually identified and lineages were poorly known.
3. Predictable and routine way of food presentation: Feed is always given at the same location and at the same time in almost all the zoos leading to a brief burst of activity starting just prior to feeding time and ceasing soon after feeding is complete.
4. Unequal space utilization of the exhibit area: Animals were often found using only some parts of enclosure usually those that were close to water source, shed and less disturbed by visitors.

5. Limited activity: Most of the animals were found resting during the day with an almost predictable activity pattern throughout the day. Lack of stimuli and novelty in the environment promote such kind of activity pattern.

6. Absence/ unusable retiring area: Most of the enclosures for deer do not have effective place where they could be brought in at times of medical care or shifting from one enclosure to another.

Evaluation of National Zoological Park Brow-antlered Deer Enclosure

There were two brow-antlered deer enclosures at National Zoological Park however only one was used as a display with the entire population of deer occupying it. It was about 4000m^2 enclosure with 54 inhabitants (13:31:10:54) at the time of the study.

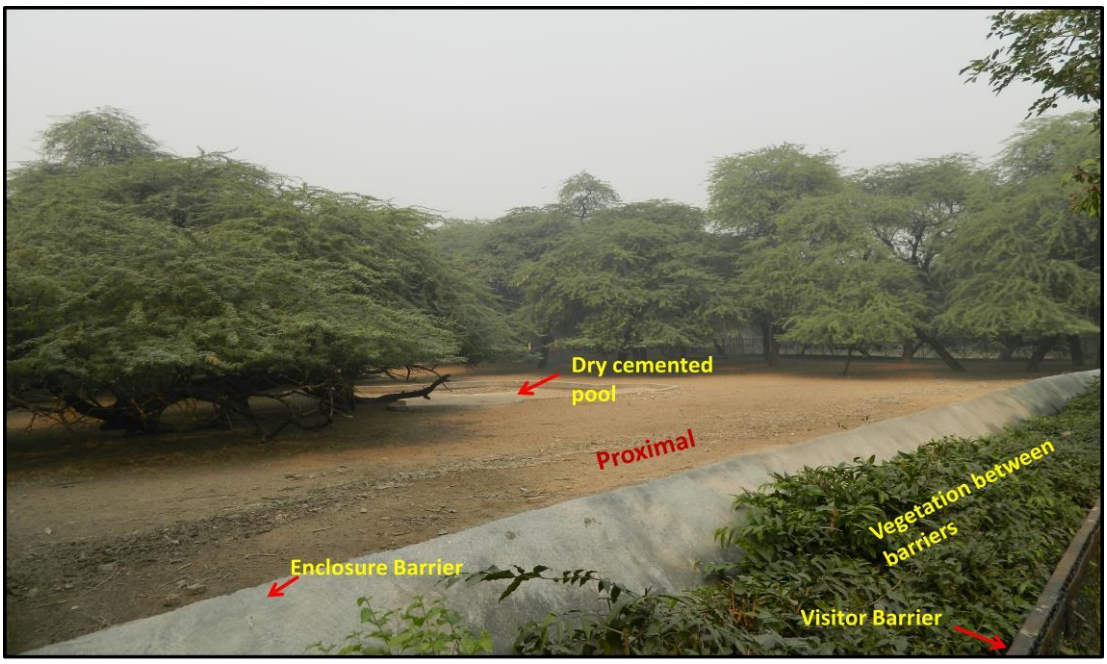


Plate 118: Brow-antlered Deer enclosure at National Zoological Park. The enclosure was large however it was barren except for thorny acacia tree species. Few logs and twigs were the only source of enrichment and the animals remained at the distal part of the enclosure most of the time.

1. Visitor Viewing Area

There was a long continuous viewing area. Visitor barriers though present; could be crossed to get inside the enclosure. Enclosure and the viewing area were at the same ground level. Animals could be seen from the viewing area however not very clearly since they were generally found resting at the distal part of the enclosure and were camouflaged by the background colour.

2. Paddock Area Characteristics

The paddock area was level ground and almost barren except for few trees. The barren ground could be quite dangerous since it could serve as source of various pathogens with continuous deposition of faeces from the animals, rodents and birds especially from the kites roosting in a large number on the trees inside the enclosure. Though the paddock was large, it was underutilized and architectural ruins were present inside.

3. Enclosure Enrichment

There was hardly any enrichment inside the paddock. There was a slightly raised concrete feeding platform, a drinking point and a dried concrete waterpool. Straw was found scattered in some areas which were seen used by the animals.

4. Vegetation Features

Except for some *Acacia* trees the paddock area was devoid of vegetation. They provided shade and their pods were fed upon by the animals. However, possibility of injury is high with thorny species like this to be present inside the enclosure.

5. Retiring Area

The enclosure has one common stable like retiring area used mainly as feeding area and a smaller cell used for treating animals. The animals were let out in the paddock all the time.

Plate 119: Brow-antlered deer resting most of the day at the distal part of the enclosure especially near the holding area

6. Socio-Ecology and Behaviour

The number of animals in the enclosure was very high for the size of the enclosure. Fighting was reported to peak at the time of breeding season. However, hardly any aggression was observed during the study period. The animals were mostly found resting together in one place most of the time.

7. Nutrition and Feeding

Feed was given thrice a day which comprised of concentrate feed, tree branches with leaves as browse and green fodder. All the feed were given inside the holding area, which could be the reason the animals were mostly found in and around the holding area i.e. in the distal part of the enclosure, most part of the day. Not only this, the lone water point was also present just outside the holding area.

Plate 120: Retiring cum kraal area where the feed were fed on the floor. Except for the fawns, all at once often the deer were observed getting inside this small area to feed

Table 25 Enrichments options for Sangai

	Enrichment Types		Species-typical behaviour targeted
1.	**Feeding Enrichment**	Hanging Food Basket	Elicit natural behaviour such as browsing and improved space utilization.
		Hanging Tree Branches	Elicit natural behaviour such as browsing and also motivate the animals to move around the enclosure

		Green fodder	Increase activity such as grazing and moving around

Plate 121: Setting up of hanging green fodder

Testing the Efficacy of Enrichments Introduced

Hanging Feed Basket: To hang green feed as browse at different locations

	Enrichment Types		Species-typical behaviour targeted
		Novel food items	Increased foraging behaviour
		Water trough	Increase usage of enclosure space
		Feeding trough	Increase usage of enclosure space
2.	**Sensory Enrichment**	Wallowing area	Elicit natural behaviour such as wallowing
		Straw mat	Increase usage of different zones inside the enclosure
3.	**Manipulable Enrichment**	Foraging twigs & branches	Increase foraging time and use of space
4.	**Environment Enrichment**	Shelter	Provide withdrawal area and shelter from the visitors as well as from con-specifics
		Levelling of ground	Provide withdrawal area from the visitors as well as from con-specifics

Each hanging feed basket comprised of two baskets joined together to make a casket like that could open and close, with the help of coir ropes. The basket could be made of any natural substance and should be in such a way that enough gaps are present for the animals to reach for green fodder. This was then fixed or tied on tree about a meter high from the ground using jute ropes. The basket was then filled with chopped green fodder cut approximately about six inches long. For our study, six hanging feed baskets were put up at different location across the paddock area.

Plate 122: Preparation of green fodder for the basket

Plate 123: Deer browsing from the hanging feed basket

Findings:

a. Instant response from the animals was observed. Activity and space use pattern were increased.

b. After introducing hanging feed browse, animals were observed in a smaller groups browsing at different locations.

c. Baskets could be hung at different height since the animals were seen browsing in the same way at every location.

d. In the absence of trees, wooden pole or logs could be used to hang the baskets.

Hanging Tree Branches: To hang palatable tree branches with leaves on the trees present inside the enclosure

As a part of daily feed, edible tree leaves with branches were provided for the deer. These leave branches were made into three bundles and were hung on trees, with the help of coir ropes, inside the enclosure at three different zones. This could serve as a browse for the deer and motivate them to walk around the enclosure.

Findings:

a. Activity and space use of the animals increased as well as prolonged the feeding time.

b. Any kind of green feed that comes in the form of branches should be hung on the already present trees. It gives a more naturalistic look and at the same time gives the animal fun to feed on in a most natural way.

Plate 124: Deer interacting with hanging tree branches hung at different points across the enclosure

Green Fodder: To provide an alternate way of presenting the green fodder

Plate 125: Deer grazing on green fodder left on the concrete slab present inside the enclosure

Novel Food Items: Adding some novel food items to give variety

Green fodder which was earlier fed inside the holding area was brought outside and placed at different zones inside the enclosure. Concrete and wooden platforms were used so that the fodder would not be in direct contact with the ground.

Findings:

a. Green fodder was a good motivator the animals to move around the paddock area. Wherever feed was present the animals followed and split into several groups, one at each location.

Novel feed in the form of carrot, French beans and additional gooseberry (amla) was brought in addition to the usual feed. Gooseberry were scattered at different places during the post-enrichment study period.

Findings:

New food items provided were not favoured by the animals. However, it is too soon to conclude that the animals would reject any other new food items in the future.

Plate 126: Water trough behind a tree

Water Trough: To provide additional water points

Metal trough that could hold around 80 litre of water was used as a means of providing additional water point inside the enclosure at two different zones. These troughs were kept behind trees in such a way that they would not be visible to the visitors.

Findings:

a. Water trough were not observed being used often by the animals however, it maybe because the study period was during winter when animals consume less water.

b. A more natural looking trough or trough made of natural substance should be used instead of metal one.

Feeding Trough: To provide a clean place to feed concentrates in the paddock area

Wooden trough of about 80m x 30m with depth of 25 m was made and stationed on two logs using ropes. The trough was held up about 0.40 m above the ground and was used as a feed trough for the concentrate feed. Four such troughs were introduced across the enclosure at different zones.

Plate 127: (a) Feeding trough (b) Filling trough with concentrate feed

Findings:

a. Provision of alternate feeding area provided the animals to choose which and where to go for feeding. Hence, activity and space use area increased.

b. Feeding trough solved the issue of not able to feed the concentrate feed in the paddock area due to hygiene concerns.

c. The feeding trough could be made of various heights and designs.

Wallowing Area: Providing wallowing area during the off-season

Enclosure ground was dry and barren with only a water point as a way of respite from fulfilling natural urges such as wallowing. There was a spot which was used as wallowing area however was not useable during winters. This spot was dug and made into a useable one for the enrichment study.

Plate 128: Refurnishing the wallowing area

Findings:

a. For animal like brow-antlered deer, presence of wallowing area provides the necessary natural urges to wallow and display certain species- specific behaviour such as thrashing antlers on the mud, etc.

b. Wallowing pond should be present throughout the year.

Plate 129: Deer at the wallowing area

Straw Mat: To provide a different substrate for the animals to rest inside the paddock

Deer were observed to prefer to rest in areas where straw was spread as carpet since the study period was during winter. Therefore, straw was brought in and placed at two different points across the enclosure

Plate 130 Deer using one of the straw mat points

Foraging Twigs & Branches: To increase the choice of feeding
Edible twigs and tree branches with leaves were scattered around the enclosure to serve as a feed as well as withdrawal for the deer.

Shelter: Provision of a natural looking shelter where animal could rest or withdraw

A shelter was made out of tree branches and shrubs using large living tree branch as a structural support. Inside the shelter the ground was carpeted with straw layers and gooseberry were scattered every morning before starting the study. The shelter was made with the aim that it could provide shelter and withdrawal area for the deer.

Findings:

a. Animals were often observed foraging the twigs and branches, and exploring the shelter.

b. Fawns were observed resting inside on the straw carpet.

c. There should be more than one such shelter inside the enclosure.

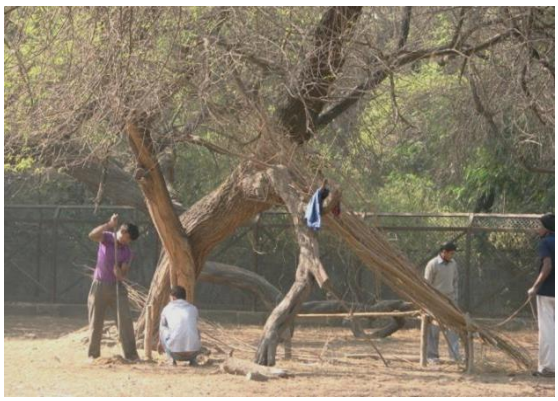


Plate 131: Deer feeding on twigs & branches

Plate 132: (a) Construction of the shelter (b) The shelter

Ground Levelling: Tidying up few area inside the paddock area

The ruin area especially was full of brick rubble, where the animals were found resting since this area provided a bit of withdrawal space. A part of this area was leveled, cleaned and provided with shrubs and tree branches to increase the withdrawal space.


Plate 133: Interaction with shelter. It was used as a shelter and withdrawal area as well as foraging area


Plate 134: Levelled ground at ruin area

Summary

Enrichment of brow-antlered deer enclosure at National Zoological Park showed the possibilities and difficulties of planning, executing and assessing various ideas of enclosure enrichment on ground. Response to enrichments items by the individual animal could differ though they are kept in same captive environmental conditions. However, for our study this has not been taken into consideration looking at large size of the herd and difficulty in identifying the individuals. Due emphasis on the social structure and interaction of the animals with one another was given.

The following points sum up our observations made during our study:

1. Problem identification was a very important step that preceded enrichment intervention.

2. Enrichments and scientific management practices increased activity and space use pattern of the animals.

3. Feeding enrichment was the most rewarding and most effective enrichment especially for ungulates. However, other enrichment types need to be tried as well. More reward based manipulable enrichment approach could be incorporated after detailed studies.

4. Providing feed in the paddock area resulted in positive changes in the activity and behaviour of the animals. It can be tried out in other herbivore enclosures as well.

5. Provision of feed inside the paddock area and at different areas provided equal opportunity and access for each and every animal to feed; thereby ensuring a more even distribution of feed.

6. Enrichment devices and strategies need to be presented on a varied schedule and in a variety of context to make sure the animals do not become desensitized or habituated to them.

7. Presence of enough enthusiastic animal care staff is essential for a successful enrichment plan since they are the one who has to look after the enclosure and continue taking care of the animals.

8. No enrichment plan or design is perfect or fixed for specific species and there should always be a scope of improving or improvising it. There has to be a constant change and innovation.