MANAGEMENT AND BEHAVIOURAL STUDY OF RED PANDA LIVING IN EX-SITU: AN EXPLORATIVE STUDY AT PADMAJA NAIDU HIMALAYAN ZOOLOGICAL PARK, DARJEELING, WEST BENGAL, INDIA.

Tejal Pohekar[1], Dr. Sumit Giri[2], Dr. Pallavi Gupta[3]

[1]Research Scholar, Department of Wildlife Science, University of Kota, Kota, Rajasthan

[2]Assistant Professor, Dept. of Zoology, Belda College, Belda, Paschim Medinipur and Chairman of BMC, Contai Municipality

[3]Assistant Professor, Department of Wildlife Science, University of Kota, Kota, Rajasthan

Abstract:

    The red panda is the only representative of Ailuridae family and listed endangered on IUCN red list. The present study was carried out in Padmaja Naidu Himalayan Zoological Park, Darjeeling from May, 2023 to July, 2023. Five individuals were selected for the study. The study showed that, if suitable enclosure, proper diet, social interaction, captive management are provided, the red pandas will breed successfully in zoo. Captive management of red pandas also play a crucial role in conservation efforts as their natural habitat continues to be threatened by habitat loss, deforestation and climate change. Captive population serve as a sort of insurance policy against extinction. Behavioural Variety Index (BVI) was calculated and analyse behavioural activity of animals under human care.

Key words: - Red Panda, zoo, captive breeding, BVI.

1. INTRODUCTION:

    Red Panda (*Ailurus fulgens*) is a very skill full and acrobatic animal of the world. Genetic research has shown that it is only representative of Ailuridae family (cat bears) (Flynn and Nedbal, 1998; Flynn *et al*., 2005). This beautiful species was described and named in 1825 by Frédéric Cuvier (Cuvier, 1825). Panda is derived from the word "Ponya" (Nepali language) which means bamboo eater (Morris and Morris, 1982). Red Panda is native to five countries of Asia consisting India (West-Bengal, Sikkim, Arunachal Pradesh, and Meghalaya), China, Myanmar, Bhutan, and Nepal. They are mostly found in high altitude temperate forests between 2,800 and 3,100 metres (Pradhan *et al*., 2001). The red panda inhabits evergreen, deciduous, and mixed forests with dense bamboo forest (Roberts and Gittleman, 1984; Wei *et al*., 1999a; Choudhury, 2001; Pradhan *et al*., 2001b). It is listed in Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Red Panda is placed in order carnivora due to their skull and jaw formation, dentition, brain, and intestine size. Its height is approximately 20-26 inches with 14 to 18 inches of tail fluffiness. The tail is marked with alternate red and buff rings. It has round head with short snout; big, erect, pointed ears. Body is covered with dense woolly undercoat with long coarse guard hairs. Dorsal part of body consists of rusty coloured fur, while belly and legs are glossy black, but feet soles are covered with white hairs. Face is light coloured with black nose and dark eyes. Each Panda has different markings on its face consisting reddish-brown marking from outer line of both eyes following towards mouth which are also known as "tear marks".

    Red Panda comes under order carnivora, but two third of a red panda's diet consists of bamboo (Bambuseae) leaves and shoots (Yonzon and Hunter, 1991; Das and Thapa, 1999; Wei *et a*l., 1999; Pradhan *et al.,* 2001), other includes berries, flowers, mushrooms and sometimes insects and fishes. Due to their low caloric intake, most of their life is spent eating. They pass most of their time in foraging, and sleeping on tree branches or in tree hollows during the day. Late afternoon and early evening hours are the most active time period of Red Panda (Yonzon and Hunter, 1991). Their dropping are the most perfect evidence to track their presence in the wild. Droppings are spindle shaped, mostly light green coloured but depends upon the food intake and age. One interesting fact about red panda is that it is the only non-primate who can taste artificial sweeteners. Scientists say, this ability helps the species to identify a natural compound in food with similar chemical structure. They groom themselves mostly like cats. Communication between two is by twittering, huff quacks or whistling sound. Alert calls are like hissing or grunting like. Red panda become sexually mature at 18 months (Roberts, 1984) and fully mature at 2 or 3 years of age, they show polygamy. Female Red Panda gather grasses and leaves to build a nest just before giving birth. For some days mother red panda lives with her litters but eventually goes out in search of food. Litter stays with their mother until next litter is born (Roberts, 1992). The geographical barriers Yalu Zangbu and Siang River tributaries of River Brahmaputra distribute Red Panda into two subspecies which are *Ailurus fulgens fulgens* (Himalayan Red Panda) and *Ailurus fulgens styani* (Chinese Red Panda) (Bista *et al*., 2021). They are mostly found in higher elevation of temperate forest and prefer to spend their life mostly on trees. Lesser Panda is a cavity nester, lives in rock dens or old hollow trees. The species population is declined to 50% in past few years in wild and is categorised as

Endangered (IUCN Red List) due to anthropogenic activities, habitat degradation, illegal trade, poaching for pet and fur (Wei *et al.*, 1999). There is big threat to the species from canine distemper due to human encroachment. Hence it is now a flagship species in Himalayan region. Highest legal protection is given to Red Panda by listing it in Schedule I of Wildlife (Protection) Act, 1972, in which, trapping, hunting, or trading in live or dead form is completely prohibited.

In India ex-situ conservation breeding programme "Project Red Panda" was first held in Padmaja Naidu Himalayan Zoological Park (PNHZP), Darjeeling. It is successful in conservation breeding from last 2 decades. First successful captive breeding in PNHZP occurred on 20 June, 1994 and two cubs 'Ekta' and 'Friend' were born (Bahuguna, 1995). By 2002 population of Red Panda increased to 22 in the zoo, after this success it was decided to re-introduce or restock the natural population in Singalila National Park. Singalila NP is a well-known habitat of resident red panda which ranges from 2,500m to 3,000m. Pre-releasing method was attempted in which radio collars were fitted for monitoring purpose. This brought a success for forest department in conservation of Red Panda. In 2008 birth population of Red Panda is reached to 50. PNHZP has 3 breeding centres; these are off display and cannot be visited except the staff itself. Two of the breeding centres named Topkeydara breeding centre and conservation breeding centre. These are for red panda and snow leopard captive breeding.

2. OBJECTIVE:

1. To observe the management, medications, food and feeding strategy for red panda.
2. To observe the hygiene management in enclosure and care of pregnant female Red Panda living in ex situ at Padmaja Naidu Himalayan Zoological Park, Darjeeling.
3. To study the captive behaviour and to investigate the behavioural variability through behavioural variety index.

3. STUDY AREA:

Darjeeling "Queen of Hills" lies in the foothills of Himalayas. It is also the best place for eco-tourism. Padmaja Naidu Himalayan Zoological Park Darjeeling was first known as Himalayan Zoological Park, Darjeeling. It was established on 14th August, 1958. And In 1975 Late Smt. Indira Gandhi the Prime Minister of India dedicated the Himalayan Zoological Park in memory of Late Smt. Padmaja Naidu; ex-governor of West Bengal. PNHZP is situated on Birch Hill (also known as Jawahar Parbat) close to natural habitat of Red Panda, Singalila National Park. This area was home to several Eastern-Himalayan faunal species. It is top zoos of world as per its conservation strategies. PNHZP has been the only Zoo in South Asia with successful conservation breeding programme of Snow Leopard and Red Panda also one in world to breed the endangered Himalayan Wolf in captivity.

Map
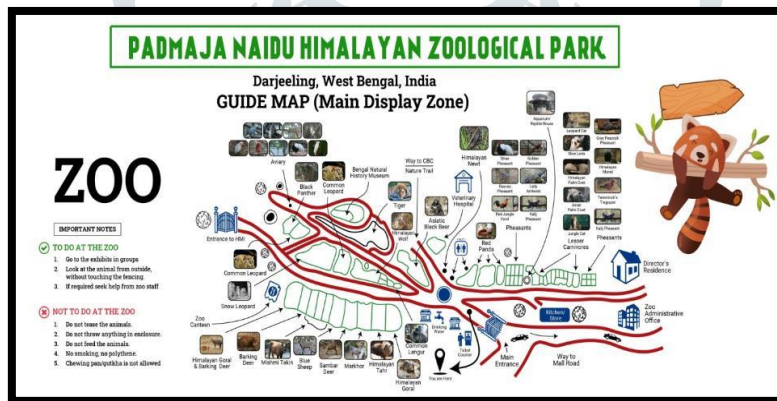
4. METHDOS:

The study was designed for 3 months. Five Red Pandas from the Park were selected for the study. Behaviour of these 5 Red Pandas was studied in two slots of 30 days. Observations were noted during morning and evening hours. Seven behaviours were selected for the current study. They were further divided into 28 classes using 0-1 sampling method and Continuous Sampling Method for behavioural study (Table 1).To study the management strategies of park, data was collected from zoo officials. They were also noted by observing the Red Panda enclosures. Five different management parameters were selected.

4.1Ethogram: Behaviour was noted by using 0-1 method and continuous sampling method for individual red panda in order to capture specific behaviours and interactions with each other. The time of observation was randomised to account for daily and weekly variations in behaviour.

The analysis of red panda behaviours in this study is based on a comprehensive ethogram of 74 red panda behaviours compiled from 930 hours of observation (Jule, 2008). In this study, a revised form of this ethogram consisting of 36 behaviours was used in order to focus on "higher-order behaviours".

An ethogram prepared for the study included 28 categorical classes that were grouped into 7 indices according to behavioural function (Table 1). 28 behaviours were compiled from the 60 hours of observations carried out on 5 individuals. The list of seven indices were assigned to the resulting classes: consumption (score: 0–3), territorial (score: 0–7), locomotive (score: 0–3), regular routine (score: 0–4), social (score: 0–8), out of sight (score: 0-1), and abnormal (score: 0-2).To investigate

the presence of species-specific behaviours related to parental care toward the cub and cubs' behaviour towards parent a separate class for this behaviour was prepared, parental (score: 0-8) (Table 1).

Table 1: Ethogram of red pandas of the study

4.2 Photo and video collection:

This study consisted of 700 photos and 3–4-minute videos of 3 months, May, 2023 – July, 2023. Animals were filmed using a Canon 1200D DSLR camera of 250mm zoom lens from the zoo visitor viewing areas.

4.3 Management and husbandry strategies:

For ex-situ Management study, data collected during the study was tabulated and analysed thoroughly. Information was collected by taking photos of different practices like feeding of animal, sanitation, and hygiene in enclosures, care of pregnant female. Data was also collected from the officials of Park.

4.4 Statistical analysis:

4.4.1. Behavioural activity pattern of individual red panda:

Indices mentioned above were used to create the Behavioural Variety Index (BVI). When calculating the indices for the red pandas, firstly, each class in Table 1 was scored as 0 or 1, where 1 represents the presence of the behaviour. Then, each index was calculated as the sum of the behavioural items performed by each red panda and the indices' score ranged from 0 to the total number of behavioural items found for each class.

A simplified Behaviour variety index (BVI) was calculated for individual red panda using the following equation:

$$BVI = \frac{Bi}{Bn}$$

Where Bi, is the number of behaviours observed in the individual
Bn, is the total number of behaviours observed in the population (N=28).

4.4.2. Comparing Behaviours of Red Panda cohabiting in same enclosure:

In the current study, different behaviours were collected in morning and evening time with the help of ethogram for duration of 30-30 minutes each. Sample of study is small, but it is sufficient to calculate the variance in red pandas cohabiting in same enclosure. The changes can be estimated thoroughly due to small sample size hence difference is shown by histogram in this study.

The goal of this histogram was to examine difference between activity patterns of each red panda showing similar activities cohabiting in same enclosure.

Consumption	Territorial	Locomotive	Regular Routine	Social	Out Of Sight	Abnormal	Parental
Eating	Digging	Arboreal	Hunting	Aggression	Not Observed.	Repetitive Route in Enclosure	Antagonistic.
Maintenance	Human Directed Behaviour	Ground	Resting	Chasing			Den.
Foraging		Standing	Comfort	Observing Conspecific		Excessive Mouth Movement.	Grooming.
	Licking		Vigilance				Observing
	Individual Play			Sexual Behaviour			Playing.
	Scent Marking			Sniffing Conspecific			Resting And Sleeping.
	Sniffing			Social Play			Transporting.
	Interspecific Behaviour			Social Resting			

5. RESULT

5.1 Red panda in Darjeeling zoo:

Captive breeding is performed in 2 breeding centres namely Conservation Breeding Centre (CBC) and Topkeydara breeding centre. CBC is near to the zoo and three enclosures are constructed in which five individuals are kept (Three male and two females).

5.2 Enclosure design:
The area meets the social, behavioural, physical, physiological needs of the species. Enclosure 1, Enclosure 2 and 3 do not consists more elevated perches, hence are easily visible by viewing public. Enclosures are covered by the rocks, grasses, logs, tress, pools etc. Night shelter is being provided if temperature drops and the food are being supplied in the

night shelter by the zookeeper from the back opening of the enclosure. Nesting boxes (wooden nest box) are planted on branches with some dry leaves in and on it for resting and pampering young ones.

5.3 Enrichment system: Climbing structures like trees, wooden poles, ropes, logs, rocks; substrate for resting, lying or nest building such as grass, leaves etc., visual barriers: log piles, trees, bamboo, and area of safe access for veterinarian examinations, shift area to allow keeper access for daytime enrichment for feeding.

5.4 Feeding pattern: In wild Red Panda feeds on maling bamboo (*Arundinaria maling*) but in the zoo pareng bamboo (*Arundinaria hookeriana*) is fed to the species because the maling bamboo is not available near zoo. To compensate his food also given apple, banana, milk, honey, and eggs. The diet is given twice a day. Fruits, milk, honey and eggs are given in the morning and bamboo in the evening.

5.5 General husbandry: Each individual red panda is observed twice a day. Data recording is a daily routine for a zookeeper where timetable is set for observation and data collection as well. Records are also collected from the concerning field such as health issues, veterinary procedures, and treatment; growth and developmental treatment; feed and feeding patterns; breeding and other husbandry aspects.

5.6 Disposals of dead animals and wastes: There is the crematorium also known as burning ghat in which the dead animals are been burnt using firewood. Burning sheds are constructed for burning the animal wastes, excreta, and other garbage materials.

5.7 Red panda management:
5.7.1 Educating visitors- Templates sticked on wall for educating visitors about red panda.

5.7.2 Veterinary section: The PNHZP park has well equipped veterinary. Regular examination of faecal samples is done to screen for Gastro-intestinal problems. Deworming is done at a regular interval of

BVI of Tuhin		
BEHAVIOUR	MORNING	EVENING
Consumption	10.60	14.28
Exploratory behaviour	29.80	20
Locomotive behaviour	26.26	17.14
Regular routine behaviour	13.13	25.71
Social behaviour	17.67	16
Out of sight	2.6	6.85
Abnormal behaviour	0	0

every three months. Some medicines are given to red panda for maintaining their fur quality and some for other body functioning like liver, bone, etc. Mineral supplements are given to red panda on regular routine interval so that no deficiency of vitamins, minerals and calcium. The supplements are often mixed in food, water, or milk so that pandas can easily intake the supplement.

5.8 Behaviour:
Here are the data tables of behaviours shown by each individual: BVI of 5 individual red pandas.

BVI of Swati		
BEHAVIOUR	MORNING	EVENING
Consumption	8.94	17.88
Exploratory behaviour	18.94	19.86
Locomotive behaviour	27.36	23.17
Regular routine behaviour	18.94	23.17
Social behaviour	19.47	12
Out of sight	6.31	3.97
Abnormal behaviour	0	0

BVI of Sunita		
BEHAVIOUR	MORNING	EVENING
Consumption	5.70	23.40

Exploratory behaviour	16.26	14.90
Locomotive behaviour	26.01	21.27
Regular routine behaviour	31.70	24.11
Social behaviour	10.56	9.21
Out of sight	9.75	7.09
Abnormal behaviour	0	0

BVI of Kitchi		
BEHAVIOUR	MORNING	EVENING
Consumption	13.10	22.56
Exploratory behaviour	24.75	10.97
Locomotive behaviour	23.30	22.56
Regular routine behaviour	27.18	24.39
Social behaviour	1.651	18.29
Out of sight	0	1.21
Abnormal behaviour	0	0

BVI of Balam		
BEHAVIOUR	MORNING	EVENING
Consumption	6.66	17.73
Exploratory behaviour	26.11	25.61
Locomotive behaviour	23.33	26.10
Regular routine behaviour	29.44	18.71
Social behaviour	13.33	8.86
Out of sight	1.11	2.95
Abnormal behaviour	0	0

5.8.1 Comparing Behaviour of Red Panda cohabiting in same Enclosure:

5.8.1. 1. Comparison of behaviours shown in morning by Swati, Tuhin and Sunita:

Consumption behaviours is seen highest in Tuhin (10.6%) then Swati (8.94%) and lowest in his mother Sunita (5.69%).

Exploratory behaviour: Maximum performance is seen in Tuhin (29.79%) then in Swati (18.94%) and lowest in Sunita (16.26%).

Locomotive Behaviour: High frequency of locomotive behaviour is seen in Swati (27.36%) thenTuhin (26.26%) and Sunita (26.0%), here the result shows there is not much difference in locomotive behaviour of Swati Tuhin and Sunita.

Regular routine behaviour: Here, Sunita shows more frequency (31.7%) as she rested or groomed herself most of the time, then in Swati (18.94%) and Tuhin (13.13%).

Social Behaviour : Swati (19.47%), Tuhin (17.67%) these two was always seen fighitng and playing in the study time and hence social behaviour does not show much difference but Sunita did not interacted with Swati and Tuhin and hence is the least behaviour shown (10.56%).

Out of Sight: All three use to be out of sight as the enclosure is big enough and due to mist in climate they were mostly not visible hence the frequency is as Sunita (9.75%), Swati (6.31%) and Tuhin (2.52%).

5.8.1. 2. Comparison of behaviours shown in evening by Swati, Tuhin and Sunita:

Consumption behaviours is seen highest in Sunita (23.4%), Swati (17.88%) and lowest in the male of the enclosure, Tuhin (14.28%).

Exploratory behaviour: Maximum performance is seen in Tuhin (20%) then in Swati (19.86%) and lowest in Sunita (14.89%) as in the evening, she was not much active as in the morning.

Locomotive Behaviour: High frequency of locomotive behaviour is seen in Swati (23.17%), Sunita (21.27%) in the evening but Tuhin showed less movement (17.14%).

Regular routine behaviour: Here, Tuhin shows more frequency (25.17%), then Sunita (24.11%) and Swati (23.17%) as she rested or groomed herself most of the time, and this estimated that there is not much difference in behaviour of all three pandas of the enclosure.

Social Behaviour : Tuhin (16%), Swati (11.92%) these two was always seen fighitng and playing in the study time and hence social behaviour does not show much difference but Sunita did not interacted with Swati and Tuhin and hence is the least behaviour shown (9.21%)

Out of Sight: All three use to be out of sight as the enclosure is big enough and due to mist in climate they were mostly not visible hence the frequency is as Swati (3.97%), Sunita (7.09%), and Tuhin (6.85%).

5.8.1. **3.** Comparison of behaviours shown in morning by Balam and Kitchi:

 Consumption behaviours is seen highest in Kitchi (13.1%) whereas Balam(6.66%) ate less during my observation time .

Exploratory behaviour: Performance seen in both were much different showing human directed behaviour. Balam (26.11%) showed scent marking more frequently than Kitchi but Kitchi (24.75%) showing individual play behaviour as well.

Locomotive Behaviour: Both Balam and Kitchi showed equal locomotion in their enclosure during morning observation i.e. (23.33%) .

Regular routine behaviour: Here, Balam showed more routine behaviour (29.44%) then Kitchi (27.18%) and this estimated that there is not much difference.

Social Behaviour : Balam was seen more socially active as he always observed Kitchi and also climb on high canopy of the tree inside the enclosure and observed conspecific of other enclosures hence his percentile for this kind of behaviour was (13.33%) while Kitchi also showed social behaviour by sniffing, observing and some time showing aggression towards Balam (11.65%).

Out of Sight: Balam was sometimes out of sight (1.11%) as he run away inside the night shelter to eat fruits or drink water. He was not visible at that time but rather than that he was always visible during observation, while Kitchi was always seen resting and grooming on canopy hence was visible all time.

5.8.1. 4. Comparison of behaviours shown in evening by Balam and Kitchi.

Consumption behavious is seen highest in Kitchi (22.56%) whereas Balam (17.73%) ate less during my observation time.

Exploratory behaviour: Performance seen in both were not much different as both were equally showing human directed behaviour. Balam (25.61%) showed scent marking more frequently than Kitchi. Kitchi (10.97%) showing individual play behaviour as well.

Locomotive Behaviour: Both Balam (26.1%) and Kitchi (22.56%) showed locomotion in their enclosure during morning observation.

Regular routine behaviour: Here, Kitchi (24.39%), showed more routine behaviour then Balam (18.71%).

Social Behaviour : Kitchi(18.29%) was seen more socially active then Balam(8.86%).

Out of Sight: Balam in the evening was much more out of sight than in the morning (2.95%) as he often performed come and go movement into night shelter, while Kitchi was often in sight during evening observation but sometimes she was out of sight whenever she moves inside the night shelter (1.21%).

Evening BVI of Kitchi and Balam

Morning BVI of Kitchi and Balam
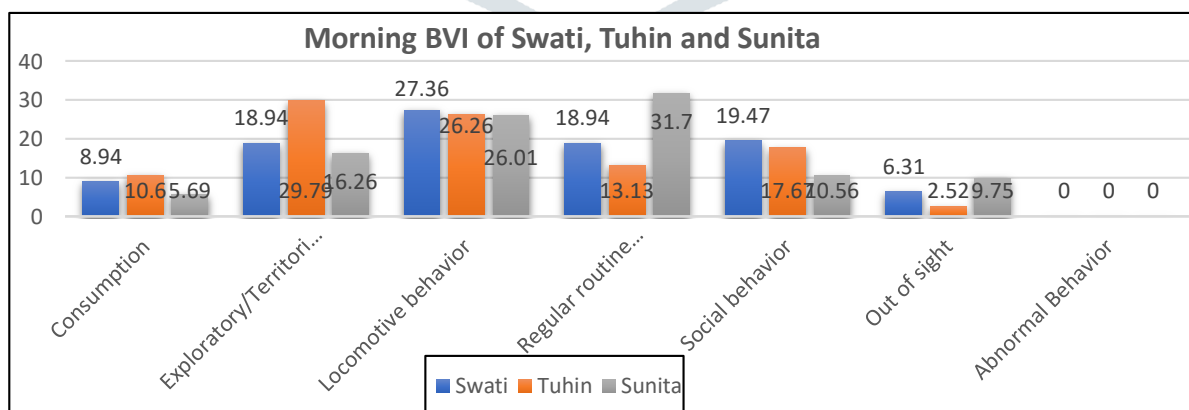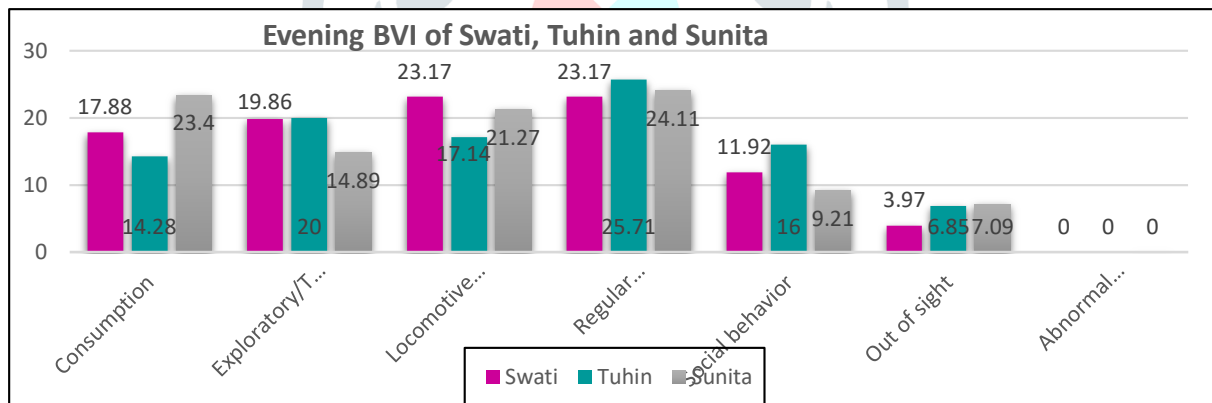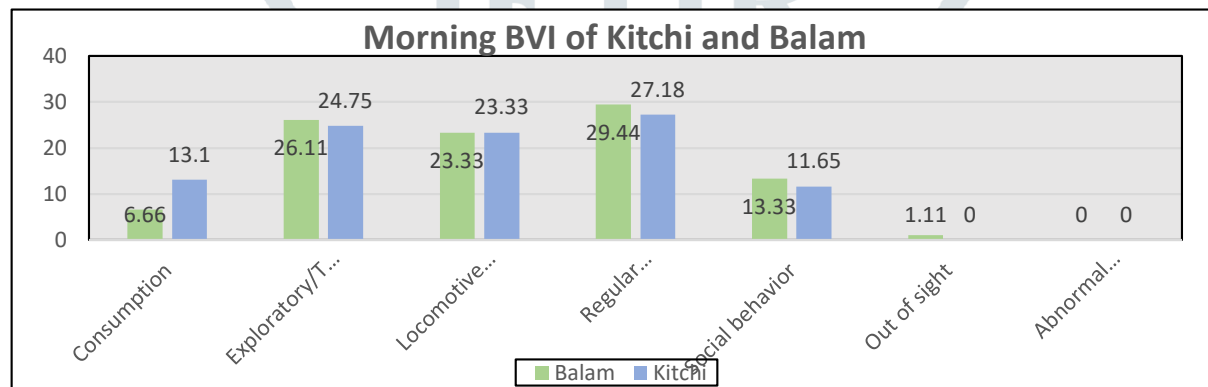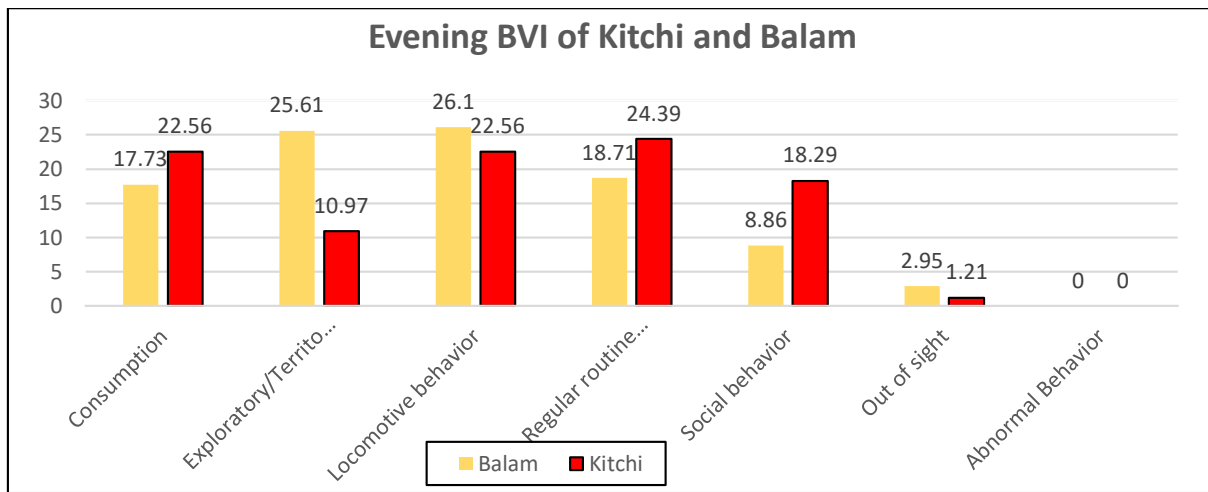
6. DISCUSSION

All the management strategies and facilities provided to red panda estimated that all the functions are performed well. The staffs are all alert and educated about the specific species. An enclosure design meets all social, physical, and psychological needs. It contains coffin boxes and night shelter where they can rest in coffin boxes and eat fruits and other food fed to them in night shelters. Enrichment systems are well organised in the enclosures. The diet is given twice a day including fruits, milk, egg, water, honey, and bamboo. Good quality bamboo is provided to red pandas which are extracted from Sencha Wildlife Sanctuary. There are 5 full time sweepers in zoo divided 1 in each beat. They use potassium permanganate for hand washing and foot dipping with fumigation done every month.

| Scent marking | Eating fruit slice | Resting | Grooming | Social play | Locomotion |

I observed no abnormal behaviour in any pandas. In the morning and evening they were active and shown all the behaviours. The result suggests that red panda shows daily activity patterns in a routine. In winters they are mostly inactive and take long rest. My observation was mostly during summer (May to July) hence activity pattern was clearly seen. Darjeeling weather is never predictable hence some days due to fog and cold weather they were inactive during those days. Results seem to agree with data collected by other researchers for red pandas in wild. Their activity level is good, factors comprising such as climate and temperature, enclosure design, food providing, daily husbandry, and enrichments which were effective in influencing the activity pattern of red panda of this study.

Though Red Pandas are arboreal, but in controlled environment, they prefer in high canopy and to stay mostly off ground. Red pandas during the study spent most of their time on high elevated perches. Being a mother, even Sunita spent most of her time on high canopy of a tree and observed her cubs from there itself. Tuhin and Swati used the ground most for consumption, scent marking and to show social behaviour. In both pairs of study, behavioural category which was performed most was locomotive behaviour and regular behaviour, including comfort, and resting (Grooming, stretching, scratching). Vigilance was seen mostly due to human disturbance. Self-grooming is relevant in this species and is performed mostly after awakening from sleep or eating food. While grooming they spend most of their time in licking limbs and body, stretching and even rubbing their back. In comparison with the 2nd enclosure red pandas, 1st enclosure pandas were mostly out of sight as 1st enclosure is large and comprises of high canopied trees. It is relevant in zoological park as animals have opportunities to hide and escape from stress - givers such as visitors.

Investigation of Behavioural variety of red pandas using the BVI was also performed. This test allows comparing the behavioural pattern with that reported in the species of both wild and captive environment. Based on previous studies on red pandas, male scent marking and patrolling behaviour is seen more than female and the above study confirms this statement. In general, all the individuals performed all behavioural items mentioned in the study except hunt in regular routine. They always showed interest and watched carefully the birds in surrounding and hear their chirping showing inter specific behaviour.

Red Pandas of the study performed all the behaviours which are typical of red pandas and indicate behavioural variety as well as proper communication towards inter specific and intra specific species. Presence of these behaviours shows good health of species and proves that all needs of animals are met. Behavioural variety measurement can be useful for assessing welfare through analysis of changes in behaviour. This will allow implementing necessary changes deriving from enrichments and other husbandry managements.

Regarding maternal care, I focused on the interaction of Sunita with her cubs (Swati and Tuhin). Based on my result, most performed behaviour was observing and sniffing cubs. The next most performed activity was playing and transport. These two behaviours were performed equally where Sunita use to walk with Swati and Tuhin for teaching them territory marking and other important factors. Sometimes she is playing with Tuhin and Swati in morning study period. Rest of the time she was seen just observing by sitting on the elevated perches of the tree. The third most behaviour performed was rest and sleep with cubs. Antagonistic behaviour was the least seen in Sunita as she never communicated with her cubs. Other behaviours like Den, Nest building was not observed as her cubs were not so young that is why she never interacted with the both much often.

7. CONCLUSION

The study is instrumental in designing effective conservation programs, promoting successful breeding, and rising awareness for the conservation of red pandas in their natural habitat. Findings of the study highlights that Red Panda did not show any abnormal behaviour during the study period, rather much positive behaviour were found that has been described in both wild and captive. Only then psychological and physical health of the species will be maintained. Lastly, monitoring conspecific behaviour (Mother

and offspring; breeding pair) might be helpful to change some strategies for red pandas under human care regarding the social housing and breeding control.

REFERENCE

Beck, B. B. 1995. Reintroduction, zoos, conservation, and animal welfare. In B. G. Norton, M. Hutchins, E. F. Stevens & T. L. Maple (Eds.), Ethics on the ark (pp. 155-163). Washington: Smithsonian Institute Press.

Bleijenberg, M.C.K., 1988. Red panda feeding hut. *The Red or Lesser Panda study book,* 5. The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, the Netherlands: 17-19

Choudhury A., 2001. An overview of the status and conservation of the red panda *Ailurus fulgens* in India, with reference to its global status. Oryx 35: 250–259.

Dendup, P., Cheng, E., Lham, C. and Tenzin, U. 2017. Response of the endangered Red Panda *Ailurus fulgens fulgens* to anthropogenic disturbances, and its distribution in Phrumsengla National Park, Bhutan. Oryx, 51 (4): 701 –8.

Dhami, B., Timilsina, S., Adhikari, A., Neupane, B., Chhetri, N.B., Sharma, A., Paudel, A., Miya, M.S., Sharma, B., Chhetri, A. 2021. Research trends, conservation issues and approaches for the endangered red panda (*Ailurus fulgens*): a systematic review of literatures across their home -range. Journal of Animal Diversity. Volume 3, Issue 2.

Ghose, D. 2005 - 2009: Red Panda Conservation Project Technical Progress Reports. WWF India-Sikkim Programme, Gangtok.

Glatston, A.R. (compiler) (1994): Status Survey and Conservation Action Plan for Procyonids and Ailurids. The Red Panda, Olingos, Coatis, Raccoons, and their Relatives. IUCN/SCC Mustelid, Viverrid, and Procyonid Specialist Group, Gland.

Glatston, A.R. & K. Leus 2005: Global Captive breeding masterplan for the Red or lesser panda *Ailurus fulgens fulgens* and *Ailurus fulgens styani* 2-42. The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam.

Glatston, A.R. 2008: Institutional summary report. Red panda study book. The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam. 1-8

Glatston, A.R. Red Panda, 2021. Biology and Conservation of the First Panda; Academic Press: London, UK.

Jule, K.R. Effects of captivity and Implications of Ex Situ Conservation: With Special Reference the Red Panda (*Ailurus fulgens*). Ph. D. Dissertation, University of Exeter, Exeter, UK, 2008.

Lubbert, J., Schaftenaar, W. and Glatson, A.R., 1993. A review of the pathology of the red panda in the period 1982-1991. In: *The Red panda or Lesser Panda studbook,* 7: 10-18, Rotterdam, Netherlands.

Pradhan, S., 1998. Studies on some aspects of the ecology of the Red Panda, *Ailurus fulgens* (Cuvier, 1825) in the Singhalila National Park, Darjeeling, India. Ph.D. thesis, North Bengal University, India.

Pradhan, S., 1999. Observation of the red panda, *Ailurus fulgens* in the Singhalila National Park, Darjeeling, India. Small Carnivore Conservation, IUCN/SSC Mustelids, Viverrid and Procyonid Specialist Group, Vol. 211, pp. 6-8.

Pradhan, S., Khan, J.A., Saha, G.K., 2000. Feeding habits of red panda in Singhalila National Park, Darjeeling. J. Bombay Nat. Hist. Soc., in press.

Pradhan, S., Saha, G.K., and Khan, J.A., 2001. Ecology of the Red Panda (*Ailurus fulgens*) in the Singhalila National Park, Darjeeling, India. Biological Conservation, 98: 11–18.

Reid, D.G., Jinchu, H., Huang, Y., 1991. Ecology of the red panda *Ailurus fulgens* in the Wolong reserve, China. J. Zool. 225, 347-364.

Roberts, M.S. 1980. Breeding the red panda (*Ailurus fulgens*) at national zoological park. Zoologische Gart., Jena., 50:253-263.

Srivastav, A., Nigam. P., Chakraborty, D., and Nayak, A.K., (2009). National Studbook of Red Panda (*Ailurus fulgens*). Wildlife Institute of India, Dehradun and Central Zoo Authority, New Delhi.

Walker, S., 1990. Red Pandas in Indian zoos: History, status, and management. The Red or Lesser Panda study book, 6. The Royal Rotterdam Zoological and Botanical Gardens, Rotterdam, the Netherlands.

Wang, X., Choudhury, A., Yonzon, P., Wozencraft, C. and Than Zaw 2008: *Ailurus fulgens*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1.

Wei, F.W., Feng, Z. J., Wang, Z.W. and J.C. Hu 1999: Current distribution, status, and conservation of wild red pandas *Ailurus fulgens* in China. Biological Conservation 89: 285-291

Yonzon P.B., Hunter M.L., 1991a. Conservation of the red panda *Ailurus fulgens*. Biological Conservation 59, 1-15

Yonzon, P.B. and Hunter, M.L. Jr., 1991. Conservation of Red Panda, *Ailurus fulgens.* Biological Conservation, 57(1991): 1-11