INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE

ISSN: 2067-533X Volume 6, Issue 2, April-June 2015: 261-270 www.ijcs.uaic.ro

SEASONAL DIET OF WILD RED PANDA (AILURUS FULGENS) IN LANGTANG NATIONAL PARK, NEPAL HIMALAYA

Arjun THAPA[*1], Khadga BASNET[2]

[1] Small Mammals Conservation and Research Foundation, P.O. Box 9092, Kathmandu, Nepal
[2] Central Department of Zoology, Tribhuvan University, Nepal

Abstract

We examined seasonal diet composition and food niche breadth of the red panda (*Ailurus fulgens* F. Cuvier 1825**)** in Langtang National Park, Nepal. The study, which was conducted in the Gopache, Dhokachet, and Trishuli areas of the park, employed field survey and lab techniques. For micro-histological analysis, a total of 161 red panda's fecal pellets and reference plants materials were collected from line transects (n = 12) laid between elevation between 3000-3600m with 150m altitudinal interval. Results showed the red panda's diet comprises eight different plant species, which were further categorized into: 'bamboo', 'tree', 'herbs', 'shrubs' and 'moss' and 'unidentified'. Bamboo (*Thamnocalamus aristatus*) ($\overline{X}$ = 245.08±15.74%) contributed the most followed by moss ($\overline{X}$ = 5.91±1.95%), Himalayan whitebeam *Sorbus cuspidata* ($\overline{X}$ = 5.83±1.22%), drooping juniper *Juniperus recurva* ($\overline{X}$ = 1.08±071.95%), Arahaga maple *Acer caudatum* ($\overline{X}$ = 1.00±0.38%), and small proportions of other species including *Rhododendron campanulatum*, *Abies spectabilis*, and *Rubus sp*. All these plants except *T. aristatus*, which is consumed in all seasons and varied seasonally ($\chi 2 > 0.001$, $df = 11$, $P > 0.05$) in their contribution to the red panda's diet. Food niche breadth determination showed a low value (0.000104), which suggests highly selective foraging. Unidentified hairs, bones and claws were also observed in few fecal samples.

Keywords: *Food habit; Langtang; Micro-histological; Niche breadth; Red panda*

Introduction

The red panda (*Ailurus fulgens)* is the sole representative of Ailuridae family in the order Carnivora. It has adopted on herbivorous diet, specializing in bamboo [1-3]. It occurs in isolated forest patches in the high mountain chain of Nepal, India, Bhutan, China and Myanmar [4 -9]. There is a small distinctly isolated tropical forest population in Maehalaya in North-East India [10]. The species is endemic to the eastern Himalaya and has been proposed as indicator species for monitoring the integrity of Eastern Broadleaf and Confer Eco-region. The distribution of red pandas is restricted to temperate forests at an altitude between 1500-4800 m. [11]. However, in Nepal the red panda is distributed at an elevation between 2800-3900m [12] and similarly concentrated in between 2800- 3000m in Eastern Nepal [13]. Nepalese protected area (PA) represent good habitats of red panda but large portion of potential habitats fall under outsides protected areas that face main dilemma in loss of habitat through deforestation and grazing pressure. The declining wild red panda population is also sensitive to poaching and illegal trade [11, 14]. The species is listed as Vulnerable on the IUCN Red List of Threatened

* Corresponding author: thapa.nature@gmail.com

Species because its population is estimated to be undergoing a continuing decline of more than 10% over the next 3 generations (30 years) [15]. As a result, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has listed the red panda on Appendix I. There is inadequate information on the red panda in Nepal. In 1989, a detail ecological study on red panda was carried out in Langtang National Park (LNP) and acknowledged as pinner species level research [7]. Since then, limited research has been conducted and didn't covered food habitats studies of target animal. Micro-histological analysis of fecal samples is an indirect method for identifying the remains of plants eaten by red pandas. Prior studies have identified that bamboo is the stable food of the red panda. However, there is insufficient information on secondary food items. An assessment of feeding ecology of red panda is also important to evaluate potential competition with livestock and other wild herbivores. Thus this paper aims to explain seasonal diet composition red panda in LNP.

Materials and Methods

Study Area

Langtang National Park ($28^0$00'-$28^0$20' N and $85^0$15'-$86^0$00'E) is located in the north of central Nepal across three districts (Rasuwa, Nuwakot and Sindhupalchock) and covering an area of about 1,710 km^2 including the Buffer Zone Area of 420 km^2. The weather is relatively dry except for January-February, and monsoon occurs in June and September. The parks consists of following vegetation zones: tropical, subtropical, temperate, subalpine and alpine, all supporting array of important mammals species such as snow leopard *Uncia uncia*, red panda *Ailurus fulgens*, musk deer *Moschus spp*, himalyan tahar *Hemitragus jemlachicus*, clouded leopard *Neofelis nebulosa*, common leopard *Panthera pardus* along with aves, herpeto-fauna, fishes and different colorful insects including butterflies [16-18].

This study was concentrated in the Red Panda Conservation Area (RPCA) covering an area of 22 sq km that includes three sites, namely Gopache, Dhokachet and Trishuli. Floral diversity portrays three major vegetation zones: the montane zone (2,600-3000m), lower subalpine zone (3,000-3,600m), and upper subalpine zone (3,600-4,000m). Broadly, vegetation compositions are *Abies spectabilis, Acer caudatum, Betula utilis, Rhododendron barbatum, R. campanulatum, R. arboreum, Sorbus cuspidata, Juniperus recurva, Lyonia ovalifolia, L. villosa, Viburnum nervosum, Ilex dipyrena, Thamnocalamus aristatus*, and *Barberis aristata*. Furthermore, habitats of RPCA are categorized into rhododendron-maple, fir-rate bamboo, fir-ringal bamboo, fir-rhododendron, rhododendron-ringal, fir-birch, maple-birch, meadows and rhododendron-juniper [12].

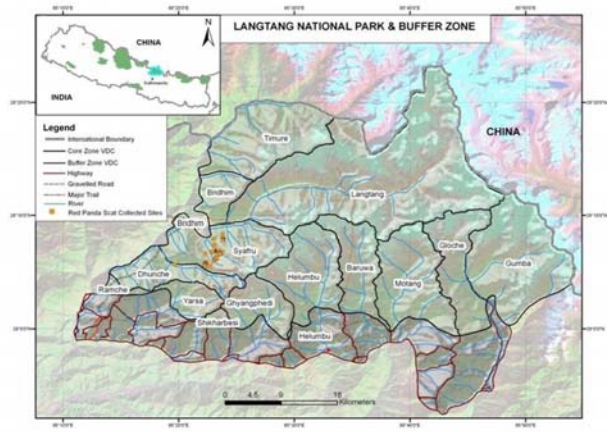

Fig. 1. Study Area (Langtang National Park)

Method

Field survey for fecal pellet collection

Based on a reconnaissance survey carried out in March, 2009, three sites were selected for intensive study. Because of the red panda's shy and elusive nature, it is difficult to directly observe feeding activity [6, 19] and fecal pellets are considered to be an effective indicator of food habits. Morphologically fecal pellets are spindle shaped, soft, moist and light green color, and distinctive from those of other animals. Fecal pellets were collected in the months of April, July and October 2009 and February 2010, representing all seasons. The altitudinal line intercepts method (20), followed by [13, 21] and was used to record the fecal signs. Each site contained seven transects approximately 0.5km in length. These were laid between 3000m and 3600m with altitudinal spacing of 150m. A total of 161 samples were collected in transects across different seasons, and all were used for the diet analysis.

Micro-histological analysis

Diet analysis was carried out using a micro-histological technique to assess diet composition and food preference [22-24]. This is considered to be one of the most accurate tools for estimating diet [25]. It is based on microscopic recognition of indigestible plant fragments, mainly epidermal features, and characteristic of different plant groups [26]. The fecal samples were collected along the line transects as described in part of field survey. Collected samples were tagged, and then stored in separate paper bags after being sun-dried separately to remove moisture content in the field. All samples were brought to the laboratory at the Central Department of Zoology for further analysis. Plant species recorded from defecation sites, were collected to prepare reference slides. Most plant species were identified in the field [27] however unidentified plants were prepared as herbarium specimen and brought to Tribhuvan University Central Herbarium (TUCH) for identification.

Both reference and fecal pellets slides were prepared by methods used in Jnawali and Shrestha et al. [28, 29].The collected reference plant samples were dried in an oven at 70^0C in the laboratory and grounded in electric blender. The grounded powder was sieved in mesh size 1mm to 0.3mm.The powder retained on the 0.3 mm sieve was chosen as final reference sample for slide preparation. These samples were treated in different concentration (10% and 15%) of sodium hydroxide (NaOH) and boiled for few minutes (5-6 minutes) in a water bath. This process was repeated until the solution became transparent. Later, it was cooled, washed with hot water to remove the NaOH and dehydrated through a series of alcohol (30%, 50%, 70% 90% and 100%). The alcohol treated samples were finally treated with a series of xylene and alcohol mixture (30%, 50%, 70%, 90% and 100%) for complete dehydration. A small amount of material was dried between tissue paper and mounted in DPX under a 24x50mm cover slip. The slides were air dried for 5-6 days. A similar procedure was applied during the fecal slide preparation, the only difference being the concentration of NaOH (10% replaced by 5% NaOH). These fecal samples were lightly washed with warm distilled water to remove dirt attached to them. A total of two permanent slides were made for each fecal sample and marked. Fecal slides were prepared and studied thoroughly as recommended by [28, 29].The distinguishable histological features (e.g. cell wall structure, shape and size of cells, hairs and trichomes, shape and size of stomata) for each species were taken as key features to compare with the fecal plant fragments. The fragments of plant reference and fecal samples were photographed using a Camera Lucida (DCMJ10) mounted on microscope. A compound microscope of 200X or 400X magnifications with an ocular measuring scale was used to read the fecal slide in horizontal transect. Finally, 20 non-overlapping fragments were identified using diagnostic key and photographs of the epidermis of the reference slide.

Numerical Analysis

Relative Frequency Percentage

Seasonal relative frequency percentage of each species in the fecal sample was estimated using following formula

$$Rf\% = \frac{n1+n2+\cdots}{N} \times 100 \quad (1)$$

Where,

Rf % = Relative frequency percentage

N= Total number of fragments identified for a given food species

N = Grand total number of fragments read

Niche Breadth

To evaluate the niche breadth of plant species included in the diet of the red panda Levin's measure of niche breadth (B) was calculated based on the following formula.

$$B = \frac{1}{\sum_{i=1}^{n} P_i^2} \quad (2)$$

Where,

P_i = Percentage of total sample belonging to species i (i = 1, 2, …, n)

n = Total number of species in all samples.

Relative Importance Values

Relative Importance Values (RIV) of each plant species observed in the fecal sample was calculated as follows using method described by [28].

$$RVI_x = D_x \sqrt{f_x} \quad (3)$$

RIV_x = Relative importance value for species x

D_x = Mean percent of species x in fecal sample

f_x = Frequency of species in fecal sample

Percentage of Occurrence (0%)

Seasonal percentage occurrence of each species of three sites was calculated by using following the formula.

$$\text{Percentage of occurrence (0\%)} = \frac{\text{Number of occurrence of each food}}{\text{Total number of fragments read}} \times 100 \quad (4)$$

Chi-square test ($\chi 2$) was used to test significant difference in food composition of red panda in different seasons.

Results and Discussion

Diet composition

A total of 161 fecal samples were analyzed. The red panda consumed leaf, shoot and fruits of eight plants in order of prevalence: *Thamnocalamus aristatus*, *Abies spectabilis*, *Juniperus recurva*, *Rubus sp.*, *Sorbus cuspidata*, *Acer caudatum*, *Rhododendron campanulatum* and moss with a few unidentified hair and bone parts. The food plants were separated into five categories: 'bamboo', 'trees', 'herbs', 'moss' and 'unidentified'. The 'bamboo' category comprised the most common food plant, *T. aristatus*, across all seasons. The other categories, which contained <9% of the plant species, was made up of supplementary food which changed according to season. The 'tree' category contained seasonal fruiting plants

and also the resting plants of the red panda. The relative frequency percentage of plants was calculated. *T. aristatus* ($\overline{x}$ = 245.08±15.74%) represented the highest proportion followed by moss ($\overline{x}$ = 5.91±1.95%), *S. cuspidata* ($\overline{x}$ = 5.83±1.22%), *J. recurva* ($\overline{x}$ = 1.08±071.95%), *A. caudatum* ($\overline{x}$ = 1.00±0.38%) and others in very low proportions (<1).

Prior study in the LNP by [12] recorded that red panda had a highly diverse diet consisting of 54-100% *T. aristatus*, locally called *Jhapra*, leaves in all seasons and complemented with succulent grasses, mushrooms, *Sorbus cuspidata*, *Sorbus mircrophylla*. Our research supports this; we found *Thamnocalamus aristatus* ($\overline{x}$ = 245.08±15.74%) made up the highest proportion of plants eaten across all seasons, while other food items varied in different seasons. Similarly, [30] identified that red panda feed on six species of plants, with *T. aristatus* as the highest constituent in LNP. Of the six food plants found by [30] during her study, which took place in the summer season, five were found during our analysis in summer. Likewise, a study carried out by [31] suggested the summer diet of red panda in Dhorpatan Hunting Reserve comprises the following six plants: *Arundinaria* spp. (81.7%), *Acer* spp. (4.5%), *Q. semicarpifolia* (3.3%), *Berberis* spp. (2.1%), and lichens (2%). Due to season overlap (summer), [30, 31] showed more similar types of food plants.

[32] in Singhalia National Park showed seasonal differences in the proportion of diet composition of red panda. The total diet comprised of *Arundinaria aristata* leaves (45%), *Arundinaria maling* (35%), fruits of *Actinidia strigosa* (13%) bamboo shoots (6%), *Sorbus microphylla* and *Rosa sericera* in small amounts. These studies were based on macroscopic analysis. Our study used micro-histological analysis, and therefore showed variation in food plants, such as *Rubus sp, Juniperus recurva* and *Rhododendron campanulatum*, in trace amounts in the different seasons. [8] Found red panda consuming *Sinarundinaria fagiana* and shoots of *Fargesia spathecea* in Wolog Nature Reserve. The study carried by [6] in Yele Nature in China showed that bamboo leaves make up 89.9% of red panda's annual diet, with animals preferring short and robust shoots supplemented by fruits and mushrooms. [33] reported that a few plant species like *Rubus elliticus* and *Arundinaria spp.* were consumed by both red panda and Himalayan black bear in LNP. In case of captive population, it was found that food constituents are different from those in wild. A total of 17 bamboo species were used as red panda feed in different zoos. Besides bamboo, various type of food such as apple, banana, pear and other fruits, vegetables, panda cake, biscuits, egg, small vertebrates etc. were found as red panda feed in zoos (38). Also, [39] recommended 200 g bamboo should be fed once a day to each captive red panda in management guidelines. Still, it was recorded 8.7% of zoos feed bamboo weekly as well as 7.2% of the zoos feed sporadically.

Table 1. Plant species eaten by red panda with their mean percent, fragment frequency (FF), relative importance value (RIV) and niche breadth (NB).

Plant Species	No. of sample	Mean	FF	RIV	NB
Thamnocalamus aristatus	157	91.25	2941	4949	0.000.104
Sorbus cuspidata	12	1.94	70	16.26	
Acer caudatum	3	0.34	12	1.19	
Rhododendron campanulatum	2	0.32	9	0.99	
Abies spectabilis	2	0.32	11	1.08	
Moss	13	2.41	71	7.99	
Rubus sp	1	0.02	1	0.26	
Juniperus recarva	5	0.38	11	0.39	

Seasonal diet composition of Red panda

Red panda diet composition varied seasonally in Chololang- Dhokachet (Table 1). *T. aristatus* was consumed in all seasons but the analysis showed that *T. aristatus* was not statistically significant ($\chi 2 > 0.001$, $df = 11$, $P > 0.05$). Other secondary food items, such as *Abies spectabilis, Juniperus recurva, Rubus sp., Sorbus cuspidata, Rhododendron campanulatum* were however seasonally significant ($P<0.05$). Likewise, red panda ingested moss in all seasons ($\chi 2 = 2.66$, $df = 7$, $P > 0.05$). Thus, secondary food plants varied seasonally ($P < 0.05$) (Table 1). In spring, the percentage occurrence of *T. aristatus*, along with *A. spectabilis, J. recurva* and *Rubus sp*., was higher compared to other seasons. The summer diet composed of *T. arisatus, S. cuspidata, A. caudatum, R. campanulatum*. *Rubus sp*. was not recorded in summer. Red pandas consumed *T. arisatus, A. caudatum*, and moss in the autumn, and *T. arisatus, R. campanulatum* and moss in winter. [32] Also suggested that the winter diet of red panda consisted of *Arundinaria aristata* (53%) and *Arundinaria maling* (47%) but the post-monsoon diet comprised 70% of *A. maling* leaves, 20% *Actinidia strigosa* fruits and 10% bamboo shoots in Singhalia National Park. Very low niche breadth (0.000104) indicated that red panda is selective feeder. The highest relative importance of species (RIV) was found in *T. aristatus.* (4949) followed by *S. cuspidata* (16.26), and moss (7.99) (*Tab. 2*). Determination of a niche usually involves the measure of some ecological variables such as food size or habitat described as narrow or broad. Niche width or niche breadth provides some indication of resource utilization by a species. Body size is the most important factor determining the metabolic rate and food requirement. Large bodied mammals have higher food requirement since they have higher cost of maintenance and production compared to smaller mammals [34]. In the present study, the niche of the red panda was calculated as 0.000104, which was quite low indicating a narrower niche. This outcome suggested that the red panda is a highly selective forager. [7] also suggested that the red panda had a highly specialized niche and diet. The wider the niche, the more generalized the species' diet is considered to be. Alternatively narrower the niche, the more specialized the species would be [35]. Most species have broader niches and have sacrificed efficiency in the use of a narrow range of resources for the ability to use a wide range of resources [35].

Table 2. Forage categories, relative frequency percentage (Rf%) of different plant species recorded in red panda fecal on the total fragments read in different seasons.

		Rf%							
Forage categories	Plant species	Spring (n=42)	Summer (n=45)	Autumn (n=42)	Winter (n=32)	Mean± SE	SD	$\chi 2$	*P*
Bamboo	*Thamnocalamus aristatus* (L, Sh)	0.949	0.897	0.909	0.895	245.083± 15.749	54.556	0	1
Tree	*Sorbus cuspidate* (F)	0	0.078	0	0	5.833±3.221	11.158	16	0.001*
	Acer caudatum (L)	0	0.007	0.007	0	1±0.389	1.348	8	0.092*
	Rhododendron campanulatum (L)	0	0.002	0	0.011	0.75±0.579	2.006	9.5	0.009*
	Juniperus recarva (F)	0.001	0	0.014	0	1.083±0.712	2.466	16	0.001*
	Abies spectabilis (L)	0.004	0	0.009	0	0.916±0.514	1.781	11.33	0.01
Moss	Moss	0.013	0	0.033	0.05	5.917±1.959	6.789	2.66	0.914
Herbs	*Rubus sp*	0.001	0	0	0	0.083±0.083	0.289	8.33	0.004*
Unidentified	Unidentified	0.032	0.017	0.026	0.043	7.667±1.017	3.525	2	0.92

*L-leaf, Sh-shoot, F-fruit, *significant level*

This study revealed that 89.5% -94.88% of the red panda diet comprised of bamboo leaves across the year. The red panda is an unusual member of Carnivora because it feeds mainly on bamboo leaves in both wild and captivity [8, 12, 32, 36]. The finding is similar to that of [6]. The summer diet consisted of *S. cuspidata*, *A. caudatum*, *R. campanulatum* as secondary food which was also reported by [30]. Among the secondary summer food, *S. cuspidata* occurred in higher amount which might due the fruiting season. Fruits like *Sorbus* and *Rubus* represent seasonal food sources that fulfill a higher caloric density than the bamboo parts [8]. However, did not found *Sorbu spp*. in the summer diet of red panda [31]. As the summer season also coincides with the period of birth and rearing of young it could fulfill the additional energy requirements. The high occurrence of bamboo in red panda diet may be because low nutrient content may help the poor digestive system of red panda. *Abies* leaves were found undigested while juniper cones, which may have been eaten opportunistically, also occurred in the diet. Moss was found in higher amounts than any other food supplement because all trees were covered with moss and the red pandas might rest on such moss mat trees and eat it as stuffer food. The presence of hair were seen in a few fecal pellets, probably because of the result of auto-grooming and grooming of the cub [7], while the presence of claw and bone might reflect cannibalism. To survive on such low nutrients red pandas have adapted morphologically, physiologically and behaviorally [14]. A lot of bamboo has to be consumed daily to fulfill the energy requirements [37]. Other authors [12] found that red pandas forage throughout the day and night because of their low nutritional diet. In sum, red pandas exhibited a foraging strategy based on accessibility, digestibility and nutritional quality adapted for maximizing their energy intake.

Conclusions

Our findings showed that the red pandas feed on eight plant species in different proportions that consists of *T. aristatus*, *A. spectabilis*, *J. recurva*, *Rubus sp.*, *S. cuspidata*, *A. caudatum*, *R. campanulatum* and moss. In addition unidentified hair, bone and claws were observed in few fecal samples. In LNP, *T. aristatus* (Jhapara) is a primary stable food for red panda and other plants comprise in low percentage in the diet that considered as secondary seasonal food supplements. The variation in the primary food *T. aristatus* was statistically insignificant across different seasons but the secondary food supplement varied in different reasons. Additionally, low niche breadth value indicated that the red panda was diet specific and had selective feeding behavior. Captive red panda population feed varied of foods which are different from natural foods. Thus, we recommend that natural food particularly bamboo should feed to captive red panda instead of biscuits, eggs, vegetables etc. in captive. We recommend for supplementary natural food such as mushrooms, *Sorbus cuspidata*, *Sorbus mircrophylla*, *Rubus sp.* should feed to captive red panda. Furthermore, collection of bamboo shoots for vegetable and pickle were still ongoing, which isn't a basic need of local people. Thus, local people should sensitize in importance of food plants of red panda.

Acknowledgements

Authors highly acknowledged to WWF-Nepal, Chester Zoological Garden UK for providing financial support, and sincere thanks to Central Department of Zoology; Tribhuvan University for Micro-histological laboratory facilities; Tribhuvan University Herbarium Center (TUHC), Central Department of Botany for taxonomic identification of plants. Furthermore, we would like to thank all the people involved directly and indirect to complete this work.

References

[1] M.C.K. Bleijenberg, J. Nijboer, **Feeding Herbivorous Carnivores**, Red Panda Biology. SPB Academic Publishing, Netherlands, 1989, p. 41-50.

[2] K. J. Warnell, S.D. Crissey, O.T. Oftedal, *Utilization of bamboo and other fiber sources in red panda diets*, **Red Panda Biology,** SPB Academic publishing, (Ed. Glatston A. R.) The Hague, The Netherlands, OR, 1989, pp.51-56.

[3] F. Wei, Z. Wang, Z. Feng, M. Li, J. Hu, *Seasonal energy utilization in bamboo by The red panda (Ailurus fulgens*), **Zoo Biology, 19**, 2000, pp. 27-33.

[4] M. Roberts, J. Gittleman, *Ailurus fulgens*, **Mammalian Species, 222**, 1984, pp. 1-8.

[5] Z. Zhang, F. Wei, M. Li, J. Hu, *Winter microhabitat separation between Giant and red pandas in Bashania faberi bamboo forest in Fengtongzhai nature reserve*, J**ournal of Wildlife Management, 70**, 2006, pp. 231-235.

[6] F.W. Wei, Z.J. Feng, Z.W. Wang, A. Zhou, J.W. Hu, *Use of nutrients in bamboo by the red panda (Ailurus fulgens)*, **Journal of Zoology, 248**, 1999, pp. 535-541.

[7] P.B. Yonzon, *Ecology and conservation of the Red panda in the Nepal-Himalaya,* **Ph. D. Dissertation,** University of Maine, USA, 1989.

[8] D. G. Reid, H. Jinchu, Y. Hunang, *Ecology of the Red Panda (Ailurus fulgens) in the Woolong Reserve, China*, **Journal of Zoology, 225**, 1991, pp. 345-364.

[9] S. Pradhan, G. K.Saha, J.K. Khan, *Ecology of the red panda (Ailurus fulgens) in the Singhalia National Park, Darjeeling, India*, **Biological Conservation, 98,** 2001, pp. 11-18.

[10] A. U. Choudhury, *An overview of the status and conservation of the red panda in India, with reference to its global status*, **Oryx, 35**, 2001, pp. 250-259.

[11] A.R. Glatston, **The Red panda, Olingos, Coatis, Raccoons, and Their Relatives. Status Survey and Conservation Action Plan for Procyonids and Ailurids**, IUCN/SSC Mustelid, Viverid and Procyoni Specialist Group, IUCN, Gland, Switzerland, 1994.

[12] P.B. Yonzon, M.L. Hunter, *Conservation of the Red Panda (Ailurus fulgens),* **Biological Conservation, 57**(1), 1991, pp. 1-11.

[13] B.H. Williams, **Red Panda in Eastern Nepal: How Do They Fit into Ecoregional Conservation of the Eastern Himalaya**, 2004.

[14] F.W. Wei, Z.J. Feng, Z.W. Wang, J.W. Hu, *Current distribution, status, and conservation of wild red pandas (Ailurus fulgens) in China*, **Biological Conservation, 89**(3), 1999, pp. 285-291.

[15] X. Wang, A. Choudhury, P. Yonzon, C. Wozencraft, Z. Than, **Ailurus Fulgens**, IUCN 2013, IUCN Red List of Threatened Species. Version 2013.1, <www.iucnredlist.org>. Downloaded on 24 August 2013.

[16] J.L. Fox, **Report on Langtang National Park. Report to NPWCO**, Kathmandu, 1974.

[17] J.R. Khatiwada, *The status of snow leopard (Uncia uncia Schreber 1778) and its conflict perception in Lantang National Park*, **M.Sc. Thesis**, Central Department of Zoology, Tribhuvan University, Kirtipur, Nepal, 2004

[18] P.B. Yonzon, J. Jones, J. Fox, *Geographic information system for assessing habitat and estimating population of Red Panda in Langtang National Park, Nepal*, **Ambio, 20**(7), 1991, pp. 285-288.

[19] F. Wei, Z. Wang, Z. Feng, M. Li, J. Hu, *Seasonal energy utilization in bamboo by The red panda (Ailurus fulgens)*, **Zoo Biology, 19**, 2000, pp. 27-33.

[20] W. Sutherland, **Ecological Census Techniques: A Handbook**, Cambridge University Press, Cambridge, UK, 1996

[21] N.K. Mahato, *Status of red panda (Ailurus fulgens) in Kangchenjunga region of Nepal*, **Tigerpaper, 31**, 2004, pp. 7-9.

[22] F.R. Anthony, N.S. Smith, *Comparison of rumen and fecal analysis to described deer diets*, **Journal of Wildlife Management, 38**(3), 1974, pp. 535-540.

[23] L.L. Baumgartner, A.C. Martin, *Plant histology as an aid in squirrel food habit studies*, **Journal of Wildlife Management, 3**(3), 1939, pp. 266-268.

[24] J.L. Holecheck, M. Vavra, R.D. Pieper, *Botanical composition determination of range herbivores diets*, **A Review Journal of Range Management, 35**(3), 1982, pp. 309-315.

[25] B.L. Dearden, R.E. Pegau, R.M. Hansen, *Precision of microhistological estimation of ruminant food habits*, **Journal of Wildlife Management, 39**(2), 1975, pp. 402-407.

[26] J.I. Fjellstand, G. Steinheim, *Diet and habitat use of Greater Indian One-horned Rhinoceros (Rhiniceros unicornis) and Asian Elephant (Elephant maximus) during the dry Season in the Babia Valley, Royal Bardia National Park, Nepal*, **M.Sc. Thesis**, Agriculture University of Norway, 1996.

[27] O. Polunin, A. Stainton, **Flowers of the Himalaya**, Oxford University Press, Oxford, UK, 2000.

[28] S.R. Jnawali, *Population ecology of Greater One Horned Rhinoceros (Rhinoceros unicornis) with particular emphasis on habitat preference, food ecology and ranging behaviour of a reintroduced population in Royal Bardia National Park in Low Land, Nepal*, **Ph.D. Dissertation**, Agriculture University of Norway, 1995.

[29] R. Shrestha, P. Wegge, R.K. Koirala, *Summer diet of wild and domestic ungulates in Nepal Himalaya*, **Journal of Zoology, 266,** 2005, pp. 111-119.

[30] K. Karki, *Habitat and feeding behaviour of Red panda (Aliurus fulgens)in Choloangpati-Dokachet Area Langtang National Park, Nepal*, **M.Sc. Thesis**, Central Department of Zoology, Tribhuvan University, Kirtipur, Nepal, 2009.

[31] P. Panthi, A. Aryal, D. Raubenheimer, J. Lord, B. Adhikari, *Summer diet and distribution of the red panda (Ailurus fulgens fulgens) in Dhorpatan Hunting Reserve, Nepal*, **Zoological Studies, 51**(5), 2012, pp. 701-709.

[32] S. Pradhan, G. K.Saha, J.K. Khan, *Food habits of the red panda (Ailurus fulgens) in the Singhalia National Park, Darjeeling, India*, **Journal of Bombay Natural History Society**, **98**(2), 2001, pp. 224-230.

[33] P.B. Chetri, *Habitat use, food analysis and threats of Himalayan Black Bear (Ursus thibetanus) in Mid-Western part of Lantang National Park, Nepal*, **M.Sc. Thesis**, Department of Zoology, Tribhuvan University, Kathmandu, Nepal, 2006.

[34] V. Geist, *On relationship of social evolution and ecology in ungulates*, **American Zoologist, 14**, 1974, pp. 205-220.

[35] R. L Smith, **Ecology and field biology**, Harper and Row, New York, 1980.

[36] K.G. Johnson, G.B. Schaller, J. Hu, *Comparative behaviour of the red and giant pandas in the Wolong reserve China*, **Journal of Mammalogy, 69**, 1988, pp. 552-564.

[37] F. Wei, Z. Feng, Z. Wang, M. Li, *Feeding strategy and resource partitioning between giant and red pandas*, **Mammalia, 63**, 1999, pp. 417-430.

[38] P. Eriksson, J. Zidar, D. White, J. Westander, M. Andersson, *Current hubanday of red pandas (Ailurus fulgens) in zoos*, **Zoo Biology, 29,** 2010, pp. 732-740.

[39] A.R. Glatston, *Management and husbandry guidelines for the red panda*, **The Red or Lesser Panda Studbook,** 5, 1989, pp. 33-52.

Received: September, 21, 2014
Accepted: March, 24, 2015