Selection of Red Panda (*Ailurus fulgens*) as an indicator species in Singalila National Park, Darjeeling, India

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**ABSTRACT**

Indicator species is an organism which indicates the condition of the environment or response to stress that is inconvenient or expensive to measure and the population density, presence/absence, reproduction success and migration of the species may be used as an index of attribute. It is mainly used to assess environmental condition as an early warning of the problem and the ecological changes occurring in the nature. In this study, effort has been made to consider red panda (*Ailurus fulgens*) as indicator species in the Singalila National Park, Darjeeling, India. Red panda is an endangered, charismatic carnivore which has converted into herbivore mode of diet. It is found in Himalayan and Hengduan mountain ranges mainly at the temperate conifer and the adjacent broad leaf forest with mainly bamboo dominance within the altitude of 1500m and 4800m above sea level. Anthropogenic pressure and rising human population is damaging the health of ecosystem and creating pressure on forest. Red panda is a solitary and shy animal and respond actively to the anthropogenic stress. Being a flagship, priority species and endemic to the region, red panda can be considered as an indicator species to monitor the ecological integrity and anthropogenic disturbance in the Singalila National Park, Darjeeling.

**Key word:** Red panda, Indicator species, Singalila National Park

**Introduction**

Indicator species is a living organism that can be easily monitored and their status reflects the condition of the environment where they are found (Landers, 1988; Cairns, 1993; Markert *et al.*, 1999; Bartell, 2006; Burger, 2006; Siddig, 2016). Response of the indicator species to a particular stress represents for the community in the ecosystem. They are sensitive to pollution, habitat fragmentation or other stress. Indicator species are developed by the researcher, scientist and managers that focus on the important facet of ecosystem which are essential for the assessment of the ecological condition (Niemi, 2004). The use of indicator species to evaluate and monitor the environmental condition is an established tradition in ecology, environmental toxicology, pollution control, agriculture, forestry and wildlife. Using indicator species to monitor and evaluate the environmental impact on animals and plants is one of the most easy and cheaper way (Noss, 1990; Lien 2007). Hall (1919) was the first person to use the concept of indicator species by associating plant and animal species to particular life zone (large geographic area with similar structure and compositional characteristics) (Carignan, 2001). According to Carignan (2001) the use of indicator species has been incorporated in the policies

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and regulation in order to monitor the ecological integrity of watersheds (Moyle, 1998), lakes (Karr, 1981; Harig, 1998), Semi natural pastures (Part, 1999 a,b), rangeland (Bradford et al., 1998) and forest (Brooks et al., 1998).

Red panda is an endangered, solitary and scansorial carnivore species of Himalayan and Hengduan mountain ranges which has adapted to herbivore diet (Roberts, 1984; Glatston, 1994; Wei et al., 1999; Choudhury, 2001; Pradhan, 2001; Li et al., 2005; Hu et al., 2011; Roka, 2014; Kumar, 2015; Roka, 2018). The habitat distribution of the animal ranges from the Himalayan belt of Nepal, India, Bhutan, Myanmar and through the Minshan Mountains and upper Min Valley of Sichuan Province in south-central China (Glatston, 1994; Chaudhary, 2001; Wang et al., 2008; Dorji, 2011; Roka, 2018). Red panda is mainly found in the temperate conifer and the adjacent broadleaf forest with maling bamboo dominance within the altitude of 1500 m and 4800 m (Prater, 1988; Catton, 1990; Yonzon, 1991; Pradhan, 2001; Chaudhury, 2001; Panthi, 2012; Kumar, 2016; Roka 2018). Red panda is listed in Appendix I of the Convention on International Trade for Endangered Species of wild fauna and flora (CITES) and in India red panda is included under the Schedule - I of Indian Wildlife (Protection) Act 1972. IUCN has reassessed the global status of red panda and placed it under the endangered category. Anthropogenic activities and associated global climate change are threatening the biodiversity in the Himalayas and have led to the extinction of many species of flora and fauna (Roka, 2018). Ecological disturbance is a frequent and important process in forest ecosystem mainly in the developing countries such as South East Asia (Lien, 2007). Red panda is a charismatic and a flagship species (Yonzon, 1991; Dorji, 2012) that has the ability to capture the imagination of the public and induce people to support conservation action. Red panda has been proposed as a suitable indicator species for monitoring the integrity of the broadleaf and conifer forest (William, 2006; Dorji, 2011; Panthi, 2012). In this study effort has been made to consider red panda as indicator species in the Singalila National Park, Darjeeling for the assessment of the anthropogenic stress, ecological integrity and habitat suitability for different faunal species in the area.

**Study Area**

The Singalila National Park is situated in the extreme North-Western boundary of Darjeeling District, West Bengal with an area of 78.6 sq km. The National Park ranges between 2400 m to 3650 m in altitude above mean sea level in the eastern part of the Great Himalayan Range, at the border of Nepal, West Bengal and Sikkim (Pradhan, 2001; Roka, 2014). Temperate zone of the park has mean temperature in summer between 7 °C to 17 °C and in winter between 1 °C to 10 °C. In sub-alpine zone, the mean summer temperature is under 7°C and in winter it is below 1°C. At 3300 m altitude and above there is regular incidence of snowfall during winter. Frost is very frequent from December to early days of March in almost 80% of the park. Mean annual rainfall is 330 cm in the park.

**Methodology**

The study on red panda in Singalila National Park was conducted between the years 2012 to 2016. Preliminary survey of the Singalila National Park was conducted to establish presence/ absence of the red panda in different blocks and compartment of the park. A questionnaire survey was conducted on a set performa for direct sighting and signs like faecal pellets among villagers, camp staff, guides, tourist, drivers, forest officials and researchers. For field surveys pre-existing tracks and trails within the forest at various altitudinal zones was used and red panda evidences were checked in the forest following Pradhan (2001). It was not possible to establish transects (Burnham et al., 1980) due to the rugged terrain and also because of the presence of dense bamboo undergrowth in the study area. Other than direct sighting, pellet/scat gives best indication of red panda occurrence in the study habitat and was used to estimate the relative abundance of the animal in the area (Pradhan et al., 2001; Roka, 2014).

There are number of proposed procedure for the selection of the indicator species (Roberts, 1985; Hutto, 1998; Kremen, 1992; Dufrene, 1997; Carignan, 2001). A simple procedure based on two quantitative criteria as proposed by Carignan (2001) was considered to select the red panda as an indicator species. Frequency of occurrence of species among area with contrasting degree of disturbance was used as one criterion. According to the author, if a species is found more frequent in relatively less disturbed area it could be considered a positive indicator of ecological integrity (i.e. species is negatively associated with the anthropogenic distur-
bances) whereas, if a species is found more frequent in a moderately disturbed area, it could be considered as a negative indicator species of ecological integrity (i.e. species positively associated with anthropogenic disturbances). In some area selection of indicator species based on frequency of occurrence may probably influence by various natural phenomena during the time of survey. Following Hutto (1998), Carignan, 2001 suggested that using the habitat specialized species is less likely to be influenced by the natural variation in the environmental condition. Population trends were used to indicate whether the qualities of the habitat of the indicator species restricted are improving or deteriorating within the time period. These two criteria were used to consider red panda as indicator species in Singalila National Park.

Results and Discussion

Studies were conducted in Singalila National Park by various researcher and the forest officials in previous years. In year 1998, Bahuguna, Director, Darjeeling Zoo, led one study in Singalila National Park where 26 red pandas were recorded in the national park and its adjacent areas. Pradhan (2001) conducted a study where about 32 individuals were sighted in the park. In the year 2012, a census was conducted to estimate the population of the red panda in the Singalila National Park and was followed by the intensive research on the ecology, food habit and the threats of red panda in the park. During the study 27 red panda were sighted in the Singalila National Park in 2012. Presence of pellet/scat gave good indication of presence or absence of the animal in the area and the habitat suitability for the species. Red panda pellets can be easily distinguished from that of other animals. During the study the frequency of the scat samples were very high near the water source, dense canopy forest, less disturbed area with high density bamboo and edibles fruits. Maximum scat samples were sighted on the branches, logs, rock surfaces and ground. Encounter rate of the red panda and the pellet groups/scat samples were highest at the altitudinal level of 2900 m to 3000 m in broad leaf temperate deciduous with 56.25 %. 18.75 % scats samples were sighted in the altitude of 2400m to 2800m which was covered by the oak forest in the undisturbed area. Direct and indirect sighting was also observed in the sub alpine forest with an altitude of 3100 to 3600 m in the Singalila National Park. During the study other faunal species like wild boar, barking deer, flying squirrel, yellow throated martin, Himalayan goral, Asiatic black bear, satyr tragopan, kalij pheasant etc were recorded in the area.

Red panda prefers mature undisturbed forest for survival (Yonzon, 1991) and it was found more frequently in relatively less disturbed area in the Singalila National Park. Therefore red panda can be considered as a positive indicator of ecological integrity i.e. the species is negatively associated with anthropogenic disturbances. Red panda is a solitary and shy animal which reacts promptly to the anthropogenic disturbances and moves from the place to less disturbed area. It provides early warning of natural responses to environmental impacts and is effective over a wide range of stress (Soule, 1985; Kelly, 1990; Noss, 1990; Marshall et al., 1993; Munn, 1993; Woodley, 1996).

Red panda mating occurs within the month of December to March, if any disturbance occurs during the mating season the pair becomes unable to copulate resulting in the decline of the population growth. Red panda gives birth to 2 to 4 cubs during breeding season which takes place between June and September after the gestation period of 120 to 150 days. Any disturbance in the area results shifting of cubs from one place to another by female red panda and during the process cub mortality and predation occurs which ultimately result in the population decline of the species in the particular habitat. Therefore population trends of red panda can also help indicating whether the qualities of the in situ habitat of the indicator species are improving or deteriorating within the time period. Therefore, red panda can directly indicate the cause of change rather than simply the existence of change (Herricks, 1985).

While selecting indicator species sufficient baseline information like the biology, taxonomy and tolerance of a taxon’s measurable characteristics of the indicator species is essential and should be understand (Hellawell, 1986; Landers, 1988; Kelly & Harwell, 1990; Regier, 1990, Pearson & Cassola, 1992; Johnson, 1993; Kremen, 1994; Hilty, 2000). Red panda being an endangered and protected animal throughout its in-situ habitat, various researches on behaviour, biology, breeding, ecology, feeding habit and threat assessment have been conducted in the different natural habitat and in captivity (Roberts, 1992; Yonzon, 1991; Wei, 1999; Choudhury, 2001;
Sharma, 2009a; Sharma, 2009b; Mallik, 2010; Dorji, 2011; Pradhan, 2001; Panthi, 2012). Red panda can be easily identified in the wild and its presence/absence can be supported by the scat/pellet in the forest. Defecation rate of the species is comparatively higher than other species and can be differentiated easily from that of other animal. Red panda being a native species of the region can function as a good indicator species, as migrant species are subject to a variety of sources of mortality on their wintering grounds and during migration (Szaro 1982; Bock 1984). Therefore, red panda can be selected as an indicator species as it is cost effective to measure and can estimated by frontline staff (even non specialist) involved in the field (Kriesel, 1984; Davis, 1989).

Conclusion

There is increasing need to find simple tool to evaluate the status of the ecosystem. During the study it was felt that it is tough to establish transect regularly due to the rugged terrain and dense bamboo undergrowth in the Singalila National Park, Darjeeling. Red panda can be used as an indicator species in Singalila National Park to assess the anthropogenic disturbance and habitat suitability for different species. Occurrence, abundance and reproductive success of the species is directly related with the anthropogenic activities. Presence of the red panda in the less disturbed area of the park gives positive indicator of ecological integrity i.e. red panda is negatively associated with the anthropogenic disturbances. Therefore, red panda as an indicator species can give information about the state of environmental quality not obtainable in other ways. Red panda can serve as an indicator species for only a narrow range of ecological conditions within the habitat type and it will not be able to represent the response of the entire ecosystem. It is not possible to measure every component of an ecosystem by using an indicator species but can be considered as an alternative for the direct measurement of the habitat as it is cost effective and quicker.

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Part, T. and Soderstrom, B. 1999b. The effects of manage-


Status and Distribution of Red Panda Ailurus fulgens fulgens in India. Dipankar Ghose, Pijush Kumar Dutta, in Red Panda, 2011. West Bengal. Whereas past work in Singalila came up with a density record of one red panda/3.9 km², no such density data are available for Neora Valley as this Protected Area has not been properly surveyed for red pandas. At Singalila [8] red pandas were found within the altitude range of 2600–3600 m. Informal records of red panda from Neora Valley indicate that this species is common and the first author has sighted red pandas in three of his six visits to this area. Ailurus fulgens. Length. 2 feet. Langtang National Park in Nepal is an important habitat for red pandas. Red pandas are often killed when they get caught in traps meant for other animals such as wild pigs and deer. They are also poached for their distinctive pelts in China and Myanmar. Red panda fur caps or hats have been found for sale in Bhutan. WWF monitors red pandas and their habitat across India, Nepal and Bhutan to better understand the species. In 2011, our work helped the government in the Indian state of Sikkim declare that the state held an estimated 300 red pandas. WWF also examines the feasibility of reintroducing red pandas to create populations in identified sites within Sikkim. Creating Community Awareness. The red panda (Ailurus fulgens fulgens) is distributed throughout the Himalayas and is found in both protected and unprotected areas of Nepal. Loss and fragmentation of habitat threaten red panda populations throughout its range, and as a consequence, it is listed as vulnerable on the IUCN Red List of Threatened Species. Despite this pressing situation, data on the ecology of the red panda in western Nepal are lacking. Our aim in the current study was to determine the distribution, associated habitats, and summer diet of the red panda in Dhorpatan Hunting Reserve (DHR), Nepal. The red panda (Ailurus fulgens) is a carnivoran native to the eastern Himalayas and southwestern China. It is listed as Endangered on the IUCN Red List because the wild population is estimated at fewer than 10,000 mature individuals and continues to decline due to habitat loss and fragmentation, poaching, and inbreeding depression. Despite its name, it is not closely related to the giant panda.
The red panda (*Ailurus fulgens*), an endangered Himalaya-endemic mammal, was once widely distributed across Eurasia but is now restricted at the southeastern and southern edges of the Qinghai-Tibetan Plateau within an altitude range of 2200 to 4800 m (3). On the basis of differences in morphology (e.g., skull morphology, coat color, and tail ring) and geographic distribution (Fig. 4), Genomic signatures of selection and local adaptation. Considering that the two red panda species live in different geographic ranges and climate environments and experienced long-term genetic divergence, we mainly focused on the identification of genomic signatures of selection and local adaptation between the two species. The Red Panda *Ailurus fulgens* (Cuvier, 1825) is recognized as one of the most elusive arboreal carnivores of the eastern Himalaya that is poorly documented. We report the first camera trap record of the Red Panda from the Prek catchment of Khangchendzonga Biosphere Reserve (KBR) in Sikkim, India. With the recent classification of red panda into two phylogenetic species, we propose “Siang river” as a potential boundary for species divergence between the Himalayan red panda (*Ailurus fulgens*) and the Chinese red panda (*Ailurus styani*). Bayesian-based phylogeny and MJ network split all the sequences of red pandas into two distinct clusters in accordance with the origin of the samples collected from the east and west side of the Siang river. The red panda (*Ailurus fulgens*) is a typical high-altitude animal, living at elevations between 2,200 and 4,800 m (Roberts & Gittleman, 1984). This species is found in the mountains of the Himalayas from western Nepal through northeastern India and Bhutan and into China, Laos and northern Myanmar (Glatston, Wei, Zaw, & Sherpa, 2015). The anthropogenic impact on red panda habitat has been identified as a major threat to the conservation of this species in its current distribution range (Acharya et al., 2018; Dendup, Cheng, Lham, & Tenzin, 2017; Dorji, Rajaratnam, & Vernes, 2012; Panthi, Khanal, Acharya, Aryal, & Srivathsa, 2017). The Langtang National Park covers the highest portion of suitable red panda habitat in comparison to other existing protected areas. The hindlimbs of four cadavers from the National Zoological Park were dissected. In addition, red pandas are similar to ursids and canids in lacking a caudal belly of m. semitendinosus, while they resemble procyonids and mustelids in the degree of fusion observed between mm. gluteus medius and piriformis. Furthermore, *Ailurus* and *procyonids* are characterized by numerous subdivisions within the adductor compartment, while red pandas and raccoons share a variable m. semimembranosus, composed of one, two, or three bellies. Lastly, a deep plantar muscle inserting onto the metatarsophalangeal joint of the hallux is described for *Ailurus*. Additional dissections of the forelimb and axial musculature of red pandas may shed further light on the phylogeny of this species.