SUMMARY

INTRODUCTION

Red panda is an important component of the Himalayan biodiversity. It is taxonomically unique in being a monotypic genus and also the only member of family Ailuridae. It is an exemplar carnivore species which has adapted to a specialized herbivorous diet of bamboo, hence scientifically important. Its distributional range extends from Nepal in the west to a few provinces of China in the east. Growth of human population in all the places along its distributional range pose as an eminent threat to the intactness of its habitat and the very survival of this species. Moreover, red panda is also known to have a low reproductive turn over with an annual recruitment of an average of only two cubs/female. The cubs that are born are very small in size and vulnerable which suffer from high mortality rate. Current information on the distribution, population status, other ecological aspects and various problems of conservation in different areas of its distribution is scarce.

In India, too, very little is known about the status, ecology, biology, behaviour and conservation problems of this species. This dearth of information has hampered conservation efforts. The present study was initiated in an effort to generate the much needed information on the ecology of red panda. The study was conducted in the Singhalila National Park, Darjeeling (in the hills of North Bengal) and had the following objectives:

1. To document the presence/absence of the red panda in the Singhalila National Park and its adjoining area.

2. To assess the distribution, status and abundance of the red panda in the Singhalila National Park.

3. To investigate the aspects of ecology such as habitat use and feeding ecology of red panda in the Park.

4. To investigate the problems of the conservation and management of red panda in the

National Park.

The study commenced from June 1994 and ended in October 1996.

GENERAL METHODS

Vegetation description of the study area: Vegetation sampling of the study area was done along seven altitudinal gradients (2700 m, 2850 m, 3000 m, 3100 m, 3150 m, 3300 m, 3450 m, 3600 m). Sampling was done by placing 10 m^2 quadrats at 100 m distance from each other. In the 10 m^2 quadrats the following variables were recorded-

Total number of trees, gbh of the trees, height of the trees and canopy cover. Another quadrat of 3 m^2 was placed within the 10 m^2 quadrat to quantify shrub species and their cover, bamboo and bamboo cover, seedlings and saplings. Disturbance factors such as grazing pressure, cattle paths were quantified using ordinal scales. Number of cut stumps were counted in the 10m^2 quadrat. Apart from this, ten individual each of 24 species of trees, six species of shrubs and a few creepers were marked to study their phenophases in order to have a better understanding of the cover and the food available to the red panda and other wildlife in the area.

Transects/trails monitoring: Transects were not laid but the existing paths and trails in the study area were used as transects, passing through different habitat types and altitudinal zones. These **trails** are referred to as **transects** in the text. These transects were monitored on a monthly basis for indirect and direct evidences of the red panda. Dung/pellet groups of the red panda were found to be the most reliable indirect evidence which was used to assess the distribution, abundance and habitat use. The pellet groups encountered during these monitoring of the transects were collected, dried and kept for faecal analysis to investigate the food items taken by the red panda.

Distribution, abundance and status: An encounter rate of pellet groups/100 hours and red panda/100 hours was used to quantify the relative abundance of the red panda in the study area. Status of the red panda was assessed in terms of the threats, relative abundance and information on the breeding population of the species in the study area.

Habitat use: The location where any direct and indirect evidence (pellet group) of the red panda, encountered during the monitoring of the transects was quantified, using ten tree method for recording habitat variables. Around this quantified habitat unit, known as the Animal Centered Plot, four more plots were laid at random in four cardinal directions from the center of the Animal Centered Plot.

Feeding ecology: Red panda food habits were investigated for different seasons by examining the faeces or droppings. The phenophases of the food plants, density and

biomass of bamboo, recruitment rate of bamboo and harvest of bamboo shoots and fruits of *Actinidia* sp. were studied to know the availability of food to the red panda. Nutritional analysis of the food items were carried out to assess the quality of the food taken by the red panda.

Conservation problems of the red panda: A socio-economic study of the villagers in the settlements in and around the National park was conducted. Apart from this, information on the various problems leading to the anthropogenic pressures on the forest resources were also recorded by talking and discussing with the local people.

ANALYSIS

Vegetation description: The data collected, was analysed for density of trees, shrubs, seedlings and saplings in different altitude. Importance Value Index was determined for all tree species encountered during the sampling. Diversity of tree species was calculated following Shannon Wierner's index and species richness was determined using Margalef's richness index. Cluster analysis was performed on the IVI of the tree species to classify the vegetation of the area. The density of the tree species in different size/girth classes was computed on per hectare basis to study the structure of the forest.

Habitat use: Multivariate techniques such as principal component factoring, ordination of the habitat plots in hypothetical species space, logistic regression were used to understand red panda-habitat relationship. The selection of habitat by the red panda was determined following Nue *et al.* (1974) and Byers *et al.* (1984). A habitat

use index was computed by dividing the recent pellet groups found during a particular season by percent distance traversed in the particular habitat type, in a season.

Feeding ecology: The pellets in the pellet groups were broken and assigned to macroscopic examination. The items present were expressed in percent volume of the total volume of all food items in the pellet. Leaves and shoots of *A. maling, A. aristata*, fruits of *Actinidia strigosa, Rosa sericera* and *Sorbus microphylla* were analysed for cellulose, hemicellulose, lignin and crude protein following Goering and Van Soest (1970) and Allen (!989).

RESULTS

Vegetation of the study area: Placing current ecological data in their correct time context is an important aspect of ecological studies. The natural vegetation of the area was subjected to intense human disturbance and asresult is greatly modified. Hence it was attempted to get an overview of the status of the vegetation at present.

Four distinct clusters of vegetation communities corresponding to the vegetation communities in altitude zones were produced by the cluster analysis. The vegetation types are Oak forest (2600 m-2800 m), Broad-leafed deciduous forest (>2800 m-3100 m), Broad-leafed coniferous forest (>3100 m-3300 m and the Coniferous forest (>3300 m-3600 m). *Quercus pachyphylla* was the dominant uppercanopy tree at 2700 m with an IVI of 81.15 and the dominant undercanopy species were *Litsaea elongata* with an IVI of 55.02, *Schefflera impressa* (IVI 36.34) and *Rhododendron arboreum* (32.10).

In the Broad-leafed deciduous forest (>2800 m-3000 m), *Sorbus cuspidata* has an IVI of 48.61 and 50..55 at 2850 m and 3000 m respectively. *Symplocus* sp., *Osmanthus sauvis*, *Rhododendron arboreum* and *R. falconeri* are the major undercanopy trees. *Sorbus cuspidata* emerges as the dominant uppercanopy species (IVI 48.61) in association with *Ouercus* sp. (IVI 43.040), *Acer campbellii* (IVI 29.42) and *Vitex heterophylla* (IVI 11.32) at the lower altitudes but this association gradually gives way to a composition where the IVI of *Ouercus* sp. is zero. The uppercanopy at 3000 m is mostly deciduous with *Sorbus cuspidata* (IVI 50.55), *Acer campbellii* (IVI 20.80). *Rhododendron falconeri* commonly known as Korlinga forms both the upper and undercanopy in these altitudes and has an IVI value of 33.13. Undercanopy, dominantly has *Symplocus sp.* (IVI 58.42 and 73.11), *Osmathus sauvis* (IVI 31.97 and 14.69), *Rhododendron arboreum (IVI 41.00 and 25.55), Meliosma dilleniaefolia* (7.37 and 10.55). At an altitude range of 3150 m-3300 m, the dominant uppercanopy species are *Abies densa* (IVI 67.59), *Betula utilis* (IVI 32.34), in association with *Litsea sp.* (IVI 19.35), *Tsuga brunoniana* (IVI 14.15), *Sorbus cuspidata* (IVI 12.78), *Acer pectinatum* (IVI 5.96) at the lower altitudinal range, which is represented by 3150 m. With an increase in altitude, that is above 3150 m, *Abies densa* (IVI 69.70) is still the dominant species but with an association of *Betula utilis* (IVI 126.49). Other deciduous trees such as the *Sorbus cuspidata, Acer* and *Litsea* species are not found. *Tsuga brunoniana* was found sparsely, only in sapling and seedling stages at 3300 m and above. The undercanopy consisted of *Rhododendron arboreum*, *Rhododendron cinnamomeum, Anromeda villosa, Meliosma delleniaefolia, Buddleia asiatica* in the lower ranges but *A. villosa, M. dilleniaefolia, B. asiatica* were not found in the higher altitudes (i.e. 3300m and above). At altitudes 3450 m and

3600 m (Coniferous forest), *Abies densa* (IVI 185.25) at 3450 m and (IVI 124.63) at 3600 m are the dominant tree species. *Betula utilis* (IVI 56.41) and *Rhododendron arboreum* (IVI 26.92) are the undercanopy species at 3450 m. *Rhododendron arboreum* becomes absent and *Rhododendron campanulatum* (IVI 93.35) dominantes towards the higher reaches, i.e. 3600 m. The broad leaf deciduous species in addition to *Betula utilis* present in this zone are *Andromeda formosa* and *Sorbus microphylla.* The density of trees was found to be lower in the higher altitudes.

Disturbance from factors such as grazing, cattle paths, logging, construction of roads, settlements was found to be prevalent in all the altitudes or throughout the study area with a higher intensity at 3100 m, 3150 m and 3600 m. Some of the uppercanopy tree species such as *Quercus pachphylla, Abies densa, Sorbus cuspidata, Betula utilis* and *Magnolia campbellii* are important to the red panda habitat in terms of providing refuge and cover. It was found that the regeneration rate of *Sorbus cuspidata, Magnolia campellii* was found to be very poor with the species not being represented in either sapling or the seeding stages. The *Quercus pachphylla* although well represented in the seedling and sapling I stages, it was poorly represented in sapling II and size class 3 which indicated an interruption in its establishment. Although, *Abies densa* was found to be regenerating well, it is a very slow growing species. Bamboo, an important component of red panda habitat was found to be extensively grazed upon. It was also found that in the study area, at present, has an overall high density of seedlings of tree species which indicates an ecological restoration but the poor representation of the dominant tree species in

immature size classes indicates an interruption in their establishment. it is thus important to give specific attention and conduct long term monitoring of the recruitment dynamics of the vegetation, especially the plant species critical to the red panda habitat. This is necessary in order to provide an intact habitat to the red panda and other wildlife species in the area.

Distribution, abundance and status: The sightings of red panda were infrequent, with a total of 32 sightings during the two years period of 1994-1996. The surveys conducted in the National Park revealed the presence of red panda in Gairibans, Kaiyakatta-Kalipokhari, Sandakphu, Molley, Sabarkum, Phalut and Upper reaches of Gorkhey. Evidences of red panda was not found in Lower Gorkhey, Rammam, Siri and Rimbick. Within the intensive area, red was more abundant in the Broad-leafed deciduous forest and the Subalpine forest as compared to the Oak forest. The encounter rate of red panda in the Broad-leafed deciduous forest was 3.81±3/100 hours, followed by Subalpine forest with 2.78± 2.2/100 hours and none in the Oak forest. Encounter of pellet groups/100 hours was 105.06±29.5, 85.00±42/100 hours and 20.31±10.05/100 hours in the Broad-leafed deciduous forest, Subalpine forest and the Oak forest respectively. The encounter rate of red panda was highest at Kaiyakatta-Kalipokahri area with an encounter rate of 3.04±2 red pandas/100 hours followed by 2.98±2/100 hours at Sandakphu and 0.44±.03/100 hours at Gairibans. From the results, it could be inferred that the abundance of the red panda was higher at altitudes above 2800 m, and sporadically present below this altitude. The lowest altitude from which red panda was reported was Upper Phedi (2400 m). A crude density of 1 red panda/1.67 km^2 was calculated for the study area. The status of red

panda in terms of abundance, breeding population and availability of unfragmented habitat, was better in Sandakphu and Kaiyakatta and Kalipokhari area than at Gairibans. However, the fact that the higher altitudes, especially Sandakphu had a greater intensity of disturbance is a matter of serious concern. It was also found that the red panda used habitats of the adjoining regions of Nepal and Sikkim. However, nothing is known or done about habitats and the safety of the animals beyond the respective state boundaries. Concerted efforts of all the three regions (Nepal, Sikkim and Darjeeling) to protect the red panda in this part of the Himalayas would therefore be a better conservation strategy rather than conserving or protecting animals within each region only.

Habitat use: Red panda was found to use two habitats- Upper hill miscellaneous and Silver fir forest in higher proportion to their availability, indicating a preference for these habitat types. Habitat use index of the red panda for different seasons also indicated a greater use of the Silver fir forest and the Mixed forest (a portion of the Upper hill miscellaneous) in relation to the other habitat types. Canopy cover, bamboo height, bamboo cover were the factors significantly contributing to classify between animal used plots and random plots. Pellet-groups were found on trees, rocks or cliffs, ground, fallen logs and tree cavities. However, maximum number of evidences were found on trees. Some of the important trees species found to be used by the red panda were *Abies densa, Betula utilis, Sorbus cuspidata, Quercus pachphylla* and *Magnolia campbellii.* Red panda evidences were significantly more on the northern aspect.

Feeding ecology: Red panda in the study area was found to consume both the species of bamboo (*Arundinaria maling* and *A.aristata*) present in the Park. There was a seasonal variation in composition of diet of the red panda. Food chiefly consisted of bamboo leaves during premonsoon and winter. There was an inclusion of bamboo shoots and fruits of *Actinidia strigosa, Rosa sericera* and *Sorbus microphylla* during monsoon and postmonsoon periods. *Actinidia strigosa* was found to have a higher nutritive value with higher crude protein, higher hemicellulose and lower content of cellulose and lignin. A variation in the food availability and composition was also found in the diet of red pandas in the temperate and the subalpine zone and also between the three study sites.

Conservation problems of the red panda in the Singhalila National Park: The primary objective of the present study was to get a broad over view of the problems of the National Park vis-à-vis the people in the settlements, in and around the National Park and their impact on the conservation of the red panda. Some of the major biotic pressures on the biodiversity of the Park, prior to the notification of area as a National Park, were due to the presence of cattle stations, poaching, logging, fire and construction of roads. Despite the various conservation programs implemented by the Forest Department, the National Park is still fraught with a number of conservation problems which needs immediate attention. Some of the conservation problems are- dependence of the local people of the settlements surrounding the National Park on the forests for fuel wood and the minor forest products, and the increasing inflow of tourists to the area. However, the environmental and economic impact of tourism on the National Park was not being

evaluated. The most apparent impact of tourism on the forest resource was found to be an increase in the consumption of firewood. Although the local benefits from tourism are not being fully realised it was found that tourism held promise of offering an alternative source of income to the local people of all the three regions (Nepal, Sikkim and Darjeeling). In order to conserve the biological wealth of this Himalayan region, it is also important to look into the well being of the locals, the ultimate guardian of the natural resources. However, any program of conservation and development in this region would bear better results if the responsibilities were shared by all the three regions (Nepal, Sikkim, Darjeeling).