SUMMARY

The leopard *Panthera pardus* is one of the large felid of Asia and Africa that is threatened by habitat loss and direct conflicts with humans. Owing to low population densities and cryptic habits leopard has remained little studied. This study evaluated landscape characteristics; determined distribution and relative abundance of leopards, analyzed diets of leopards and assess the extent, nature of human leopard conflicts and examined habitat use and preference in and around the Chitwan National Park and Buffer Zone (CNPBZ), Nepal. Methodologies used to accomplish these objectives included remote sensing, geographic information system (GIS), ecological field work (line transect sampling for prey, camera trapping for leopard and scat collection), social surveys and lab work for diet determination using micro-histological technique.

Supervised maximum likelihood classification of ALOS image delineated 16 land cover types: 4 types of Sal forest associations (*Shorea robusta*) (lowland Sal, mixed Sal, degraded Sal and hill Sal), 3 types of Riverain forest associations (*Trewia-Bambax, Acacia-Dalbergia*, and mixed riverine), 2 types of short grassland associations (flood plain grassland and short grassland), 3 types of tall grassland associations (swampy tall grass, tall grass and wooded tall grass), 2 types wetlands (rivers and lakes), exposed surface and the cultivated lands. Most extensive land cover category in the park was Sal forests (73%) followed by grasslands (12%), riverine forests (7%), exposed surface (5%) and water body (3%). Level of accuracy of supervised classification was high (84.53%). Landscape was heterogeneous with 6994 fine patches of different sizes and configurations. Patches characterized by density of 1.43 km\(^{-2}\), mean patch size of 64.6 ha, low value (0.33%) of conectance, high value (98%) of aggregation index (AI) and even interspersion (IJI = 76%) in the landscape.

Prey populations were sampled from the elephant back through 34 four line transects (ranging from 2 to 6 km) in three different blocks representing climax Sal dominated forest (12 transects), area of previous settlements (10 transects) and buffer zone (12 transects) in the northern part of CNPBZ. Prey survey was done 4 times in each transect for each of summer and winter season for two years from 2007 to 2009. Overall estimated density using program DISTANCE ranged from 84.3 to 123.9 km\(^{-2}\) in different blocks. Estimated densities of chital (*Axis axis*) ranged from 59.3 to 117.7 km\(^{-2}\), wild pig (*Sus scrofa*) from 3.5 to 16.1 km\(^{-2}\), hog deer (*Axis porcinus*) 11.3 to 13.0 km\(^{-2}\), Sambar (*Rusa unicolor*) 5.4 to 12.7 km\(^{-2}\), barking deer (*Munticus muntjac*) from 3.6 to 5.5 km\(^{-2}\) provided a biomass of 6966 kg km\(^{-2}\). Ungulate density and
biomass in the study area was found to be high compared to those from other areas in the Terai and even south Asia. The density of ungulate prey species was reported to increase by 309% since 1982, probably due to effective management and removal of livestock and human pressures.

Abundance and density information forms the baseline for conservation planning. Camera-trap surveys were carried out during winter 2008/09 and 2010. A total of 27 different individuals were captured (15 male, 10 female and 2 two of unknown sex) during a survey I (256 camera stations, 3840 trap nights) and 37 different individuals were trapped (20 females, 16 males, and 1 of unknown sex) during the survey II (310 sampling stations, 4650 trap nights). Leopard density estimated during survey I and II was 4.24 and 3.11 100 km\(^{-2}\) respectively using half MMDM method, 4.06 and 3.48 100 km\(^{-2}\) for the full MMDM under M\(_h\) model and 3.12 and 3.45 100 km\(^{-2}\) SECR method. The spatially explicit approach accounts for animal movements on and off the trapping grid in a formal way and is therefore preferable over the non-spatial approach.

Since predator ecology is largely governed by their prey, understanding a predator’s foraging ecology can contribute to its conservation. Micro-histological scat analysis (n= 263) revealed that leopard consumed 15 different prey taxa (10 wild and 5 domestic) predominantly medium sized ungulates in Chitwan. Leopard diet constitutes of wild ungulates (78%), domestic animals (12%), birds and rodents (6%) and primates (4%). At the species level, chital comprised 45.8% of the relative frequency of occurrence. Biomass contribution of wild ungulates, domestic prey and small sized wild prey were found to be approximately 84%, 13% and 3% respectively. Chital contributed about 52% of biomass in prey rich habitat, while in prey poor habitat its contribution was 14.3% of total diet. In prey poor habitat livestock, primates, birds and rodents contributed 50.8% of leopard diet against 11.7% in the CNP. Multinomial likelihood ratio test confirmed non-random predation by leopard (\(\chi^2 = 20.66, \text{ DF} = 4, P< 0.001\)). Selectivity estimates using group density revealed that the leopard consumed chital in greater proportion than availability, and hog deer, barking deer and wild pig were taken less than expected and consumption of sambar was in proportion to its availability.

Using livestock damage data and household questionnaire survey (n=180), I investigated the extent, patterns and financial loss of livestock kills by leopards and compared with that of tigers and local perceptions towards the conservation of large cats. Leopards and tigers were accounted for killing of approximately 57 and 54
animals/year respectively. Leopard primarily preyed on small stock mostly on goats (92.17%), while tiger killed goats (57.67%) as well as cattle (25.12%) and buffalo (12.56%). A significant association was found between prey size and predator types ($\chi^2 = 91.97, P < 0.001, df = 1$). Livestock depredation by both cats showed seasonal, monthly and geographic variations. Reported loss amounted to US $ 13,727 per year, of which 36% accounted by leopards and 64% by tigers. Majority of local people expressed positive perceptions towards leopard (67%) and tiger (68%) due to the importance of these felids in the natural ecosystem, tourism and religion/culture. Though majority of respondents were not satisfied with current compensation system because of slow process and inadequate, still 47% accepted a slight increase in the population of large cats. In order to reduce depredation, livestock particularly goat should be kept in improved pens. Strengthening of buffer zone management program would be an important step forward for human- large cat coexistence.

Using camera trap data and landscape variables derived from remote sensing and GIS, I evaluated habitat use and effect of landscape and anthropogenic factors on habitat utilization of leopards in the CNPBZ using availability and use approach. A total of 178 independent photographic events were obtained from 566 trap locations. Leopards used habitat disproportionately to their availability ($\chi^2 = 12.65, df = 6, P = 0.04$) in Chitwan. Leopard utilized more often grassland and Sal forest habitats than expected, while riverine forest and riverbed complex were used less than availability. Leopards negatively associated with the distance to forest edge and jungle roads, while the topographic variables and distance to water did not significantly influence habitat use. Leopard activity was found to be slightly higher during the night time (52%). Activity patterns showed, males were more nocturnal (62%) and females were more diurnal (61%), while both sexes were crepuscular more active between 16.00-22.00 hours. Leopard was found to be a generalist in habitat use but not a super generalist as presumed.

This study provided much needed baseline information on habitat characteristics of CNPBZ, abundance of leopard and prey population, feeding ecology and prey selection by leopard, leopard- human conflicts and habitat use of leopards. While sampling occasions were short, this study had the largest number of camera traps and trap efforts in south Asia. The baseline data generated by this study will be a good starting point to conceive a population monitoring program, ecological research and more dedicated management programs in future.