EVALUATING PANNA NATIONAL PARK WITH SPECIAL REFERENCE TO ECOLOGY OF SLOTH BEAR (*MELURSUS URSINUS*)

FINAL PROJECT REPORT

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EXECUTIVE SUMMARY

A study on behavioural ecology of the sloth bear was carried out in Panna National Park (NP), central India, from 1996 to 2000. Dry deciduous forests probably hold a major proportion (about 50%) of the sloth bear population in India. Degradation of habitat by humans has also been greater in this forest type. For informed conservation planning and management of this habitat and the bears that inhabit it, it is essential to have baseline information on the behaviour and ecology of bears in that habitat. Further, conducting a study in a human impacted area would lead to an objective assessment of how various human impacts affect bear behaviour. These considerations made us study sloth bears in Panna NP, a partly human degraded, dry deciduous forest habitat.

Broadly, the objectives of this project were to study the key behavioural aspects of sloth bears: their daily and seasonal activity, space use and habitat selection, food habits and feeding behaviour and assess the ecological factors that influence these behaviour; to assess the habitat requirements of bears; to evaluate the habitat quality of Panna NP for sloth bears; to asses the impact of habitat degradation on sloth bear space and habitat use; to study sloth bear conflict with humans and identify the behavioural and ecological factors that lead to conflicts; and to develop a survey design for monitoring sloth bear population changes over time, using sign indices. We hope that the results of this study would help in better conservation of sloth bears and their habitat and also lead to better management of conflict between bears and humans.

Activity patterns and underlying influences. Animals perform various activities related to their survival and reproduction during their daily and seasonal cycles. The patterns seen in timings of activity are largely a reflection of interactions between physiology and ecology of an animal. The patterns in daily and seasonal activity of sloth bears were studied and the factors that influenced the patterns were assessed. Activity states were recorded by monitoring radio-collared bears and by deploying automated receiver-recorder units that logged activities from motion sensors fitted on

bears. Daily and seasonal changes in temperature and relative humidity of the microhabitats used by bears (dens, shrub cover, etc.) were recorded using temperature and relative humidity (RH) loggers. Tiger and human activities were monitored to assess the influence of these on bear activity patterns.

Bears were found to be essentially nocturnal and crepuscular in activity and they rested during midday, in all seasons. The bears started their activity in the evenings, after their long midday rest, were active through the night, and ended their activity in the mornings. Overall, bears were active for 48% to 54% of the whole day (out of 24 h), in all seasons. They rested during day mostly in natural dens found commonly in the escarpment habitat (50% to 85% usage), and in dense cover provided by *Lantana* shrub thickets (15% to 50% usage). The relative usage of these two microhabitats for day-resting by bears varied considerably among seasons and individual bears. The individual behavioural differences were explained to a large extent by the location of their home ranges. The use of escarpment was predominant during dry season months and decreased during monsoon and post-monsoon months, with a converse increase in the use of *Lantana* habitat. In the forest-open habitat, temperatures were the highest and temperature ranges were the largest in the dry season. RH values were the highest in wet season and the lowest in dry season. Among the different microhabitats, temperature variability was the lowest in dens.

The radioed bears gave birth in the cold season in “maternity dens” and stayed inside those dens caring for the cubs for several weeks. This period of staying inside den during and after parturition, termed “cubbing period”, ranged from 9 to 12 weeks, from end of November until February.

Diel activity patterns of bears and tigers were largely similar. Human activity too overlapped with bear activity during early morning and evening hours. Tiger or human activity did not seem to influence bear activity patterns. Bear activity in day time seemed to have an inverse relationship with temperature in forest-open habitat. Day time thermal conditions seemed to have the greatest influence on bear activity and selection of habitat for day-resting, out of the explanatory ecological factors considered in this study. Importantly, bear activity timings, rather than responding to concurrent

environmental stimuli, seem to have been synchronised with time of day, probably founded on an endogenous circadian rhythm.

Escarpment and knoll habitats provide caves and crevices that serve as excellent shelters for bears to rest during daytime. In addition, these habitats provide secure dens for cubbing. Escarpment and knoll habitats that offer such shelters should be included in the protected reserves to ensure protection. Areas with dense shrub cover should be maintained, particularly in the peripheral areas, even if it consists purely of *Lantana* shrub. Human usage of escarpment and knoll habitats should be restricted to reduce disturbance to bears and also to reduce encounters between them.

Space use and habitat selection. Information on habitat features used by an animal, and the ones that are preferred or avoided are needed to understand many ecological aspects of the animal, and further to plan for its conservation. We studied sloth bear space use and habitat selection in Panna NP, by fitting radio-collars to 12 bears. Nine bears (5 females and 4 males) were monitored for periods ranging from 3 to 32 months (a median of 18 months), and over 4,000 radio relocations were logged in total. Habitat map of the study area classified using satellite imageries was used to assess habitat selection. Habitat quality, in terms of resources required for survival and reproduction of sloth bears, was assessed by measuring characteristics such as food plant densities, prey insect colony densities, canopy, shrub cover, etc., in uniformly spaced locations spread over the study area.

For 9 bears, 3,219 relocations were used in home range estimation and habitat use analysis. The number of relocations for each bear ranged from 57 to 728, with a median of 382 relocations. Six bears (4 females and 2 males) had year-round tracking data covering all seasons. 95% fixed kernel estimates of total home range sizes ranged from 12.4 km^2 for a female to 85 km^2 for a male. The annual home range sizes were similar to total home range sizes for all bears. Annual, seasonal and total home range sizes of male bears were, on an average, larger than those of females. However, from this rather small sample of radio-tagged bears, no strong inference on sex difference in home range sizes could be made. The range sizes were not

much different among seasons for females, while they were considerably different for males. Home ranges of male bears showed extensive spatial overlap, whereas, that of females were spatially separated to a considerable extent. There was a high overlap in home ranges between sexes. Again, the small sample of radio-tagged bears limits us from discerning patterns and making strong inferences. Seasonal shifts in location of core ranges and changes in habitat use were observed. The bears that had substantial dense forest (and associated escarpment) habitat within their home ranges used that habitat frequently in the dry season. Some bears shifted to more open habitats in wet and cold seasons.

The annual home ranges of bears had varied habitat composition. Some were randomly placed within the study area (habitat composition of home range was in proportion to availability within study area), while others showed selection for (= 'preference') particular habitat types. All bears seemed to have consistently selected against (= 'avoided') degraded scrubland while placing their home ranges. Overall, dense shrub habitat was preferred, and short-grassland / open-savannah and degraded scrubland habitats were avoided in placement of home ranges. When habitat composition of actual locations of use was compared with habitat composition of space considered available for each bear (Johnson's 3rd-order selection), dense forest and dense shrub habitats were preferred and open forest and short-grassland / open-savannah habitats were avoided by bears.

Density of trees and key food plants of sloth bears was the highest in dense forest habitat, followed by open forest, dense shrub and other habitats. Degraded scrubland habitat was the poorest in terms of diversity and densities of food plants and other trees. Dense forest habitat had the highest colony densities of important prey taxa of ants and termites, followed by open forest and open shrub habitats. It appears that the bear home range sizes are related to the abundance of resources within home ranges. The limited data suggest that home range size may be negatively correlated to proportion of dense and open forest (the 2 resource-rich) habitats, positively correlated to proportion of open shrub and degraded scrubland (the 2 degraded) habitats, and negatively correlated to combined density of 4 main food plants, in the

home range. Further, bears seem to have avoided habitats degraded by humans, and these degraded habitats were lower in quality, in terms of resources for sloth bears. Food plant, total tree, and insect colony densities were higher in the preferred habitats as compared to avoided habitats.

About 21% of Panna NP area is composed of open shrub habitat and another 6% is of degraded scrubland and barren land. Restoration of the degraded habitats, which were of lower quality for sloth bears and which were avoided by them, could improve sloth bear reproductive success and survival in the Park. Dense shrub habitat, even though dominated by weedy *Lantana* sp. shrub, should be maintained at least in patches, due to their value as cover for sloth bears and many other animals. Since the dense shrub habitat also had a high density of trees, the dense shrub cover may have been facilitating regeneration and recruitment of trees. This habitat eventually can get restored as a higher quality habitat for bears. Dense forest habitat, which is found mainly along escarpments, seems crucial for sloth bears for cubbing and day-resting, and so its degradation by humans should be prevented. If additional dense forest habitat along escarpments is available in the vicinity of the Park, they should be brought under the jurisdiction of the Park. Further, human use in areas surrounding the Park should be regulated, so that the habitats do not become severely degraded and completely devoid of patches of dense cover.

Feeding behaviour and food habits. Food abundance in an area and the consequent nutritional status of animals directly influences their reproductive success. Food habits and distribution of food resources further influence ranging patterns, home range sizes and other behaviour of animals. Thus, information on food habits and food abundance is important for studies on behavioural ecology and has substantial conservation implications. We studied sloth bear feeding behaviour and food habits in Panna NP, examined the influencing factors, and investigated why some resources were chosen over others. Foraging observations were made by observing radio-collared and other bears, and diet composition was estimated by faecal analysis. Energy content of various food items was determined by bomb calorimetry.

Fruits contributed 56%, ants 29%, and termites 10% to the annual diet, in terms of ingested biomass. The relative energy contributions of these were similar to relative ingested biomass. Among fruits, *D. melanoxylon* was the highest contributor, followed by *Z. mauritiana,* and among insects, *Camponotus* spp. ants made the greatest contribution to the diet, followed by *Dorylus labiatus* ant. Termites contributed a smaller, but a consistent portion (about 10% to 25%) during most months. Fruits and ants complemented each other and constituted 70% to 95% of the diet. No relationship between relative productivity of various fruit species and their relative contribution to annual diet was found. This indicated a selection by bears among the fruits. Fruits of *D. melanoxylon*, *Z. mauritiana* and *C. fistula* were selected, as they were consumed in a higher proportion to their productivity. The bears fed on insects in proportion to their relative abundance. Plant abundance, dispersion, fruiting length, fruit bite-size, fruit presentation, and ripe fruit taste are the plant traits, and colony abundance, colony size, and colony biomass are the insect traits selected by bears.

Foraging behaviour and food habits of sloth bears in Panna suggest that they are omnivores, with adaptations for myrmecophagy. Sloth bear is the only bear species that seems almost entirely dependent on social insects for its protein requirements and thus, in this respect, is unique among bears.

Conflict with humans. Resolution of conflict between humans and animals may greatly influence the survival of animals and therefore, has crucial conservation implications. Wildlife management itself, frequently, is about managing these conflicts that occur at various levels. Resolution of these conflicts is also essential for local acceptance and support of conservation efforts. We investigated the behavioural and ecological conditions that led to attacks on humans by sloth bears in Panna NP, and identified measures that could reduce the frequency of attacks. We surveyed villages and interviewed people who had close encounters with sloth bears and who used forest areas intensively, and gathered information on various parameters associated with attack incidents and encounters. We used the data on other aspects of

behavioural ecology of sloth bears to identify the possible factors underlying the attacks.

Thirty villages had reports of bear attacks, totalling 80 incidents. Humans and sloth bears in Panna NP avoided direct encounters and only a small proportion of encounters resulted in attacks. Bears attacked primarily when the encounter was sudden, and this was probably a defensive response. No attack in Panna NP appeared to have been deliberate. The majority of the attacks took place in escarpment or other dense vegetation cover habitats, in the crepuscular period of wet and cold seasons. The frequency of attacks on humans engaged in various activities was influenced by the intensity of their usage of different habitats in different seasons. The period of overlap in human and bear activities was longer in the wet and cold seasons and in the evenings than mornings in all seasons. Most attacks happened during these periods of high overlap in habitat use and activity, and in those habitats of greater simultaneous use. It appears that the habitat conditions often made the encounters sudden and the behavioural response of bears during such encounters caused the attacks.

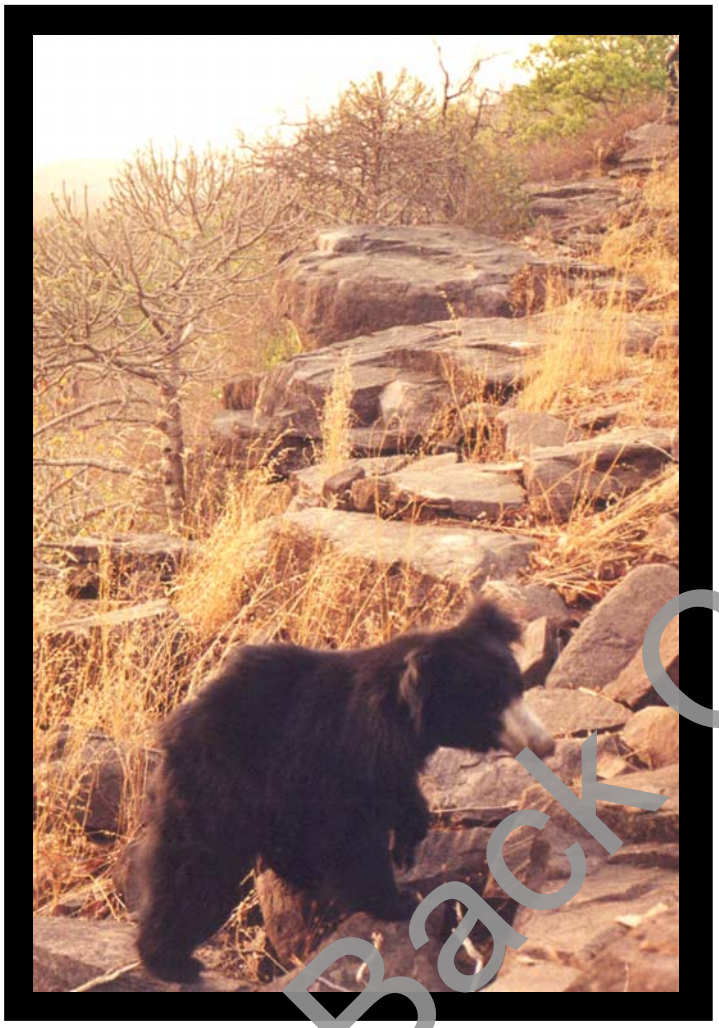
As suggested by the results of this study, the circumstances that lead to sudden encounters can be avoided and thereby the frequency of attacks can be reduced. The problem solving required here involves management of human behaviour in bear habitats. Suggested measures include: stopping night time usage of forests by humans, such as for grazing buffaloes; restricting humans from using footpaths in the escarpment habitat; making paths wider in *Lantana* patches; relocating forest blocks that are open for grazing and the forest villages away from escarpments; and extending the Park boundary to include most of the neighbouring escarpment habitat. The results of this study would apply to most places where the sloth bear attacks are defensive. The results can also serve as a model for evaluating causes of attacks in other areas and for predicting situations that might lead to attacks.

Designing sign surveys. Estimating abundance and monitoring populations are important aspects of species conservation. Given the high cost of estimating population size, assessing trends in populations using relative

abundance may be an acceptable alternative for tracking the status of a species, or for evaluating the success of management. We developed a rigorous survey design for monitoring sloth bear population trends using scat and digging signs. Our objectives were to determine if sign surveys are a suitable means of monitoring sloth bear population trends and to evaluate design considerations for such surveys, addressing issues such as time of the year surveys should be conducted and appropriate spatial and temporal layout and design for such surveys. To meet these objectives, we conducted initial surveys to serve as a basis for evaluation and conducted power analyses to assess design considerations suitable for Panna NP and elsewhere.

We counted sloth bear scat and digging signs in 2-km segments along 100 km of survey trails every 15 days from January 1998 to October 2000, in Panna NP. There was considerable seasonal and annual variability in the detection rates of scats and higher variability in digging detection rates. We fitted beta-binomial models to the sign detection rates and used this for power estimation for Panna counts and modified the models to evaluate sample requirements for alternate sampling designs and varying sloth bear density. We applied effect size to relative density rather than sign occurrence and estimated sample requirements for minimal ($\alpha = \beta = 0.2$) and desirable ($\alpha = \beta = 0.1$) survey designs for detecting declines of 25% and 50% over 2, 5, and 10 years. Scat surveys yielded greater power than digging surveys, but power was increased over that of scat survey if diggings were also included in the analysis. However, these surveys are best used to track trends over time in an area and not to compare different areas.

For the programs that aim to monitor population trends using sign indices to be effective, assessment of properties of the index, rigorous designing of surveys, evaluation of the effects of modifications to the design, and assessment of the cost-effectiveness of the survey are necessary. Our method of designing surveys could be a model for such effort.



Sloth bear's large size, wide distribution, curious habits, remarkable physical and behavioural adaptations, and its vulnerability make it an interesting behavioural ecology research subject.

Behavioural ecology of sloth bear was studied in Panna National Park, a partly human-degraded, dry deciduous forest in central India, from 1996 to 2000.

Key behavioural aspects of sloth bears: their daily and seasonal activity, space use and habitat selection, foraging behaviour and food habits were studied, and the ecological factors that influence these behaviour were examined. Sloth bear conflict with humans was assessed and the factors that lead to such conflict were studied. A survey design to monitor sloth bear population changes over time, using sign indices, was developed.

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