Sloth bear habitat use in disturbed and unprotected areas of Madhya Pradesh, India

Naim Akhtar[1,3], Harendra Singh Bargali[2,4], and N.P.S. Chauhan[1,5]

[1]*Wildlife Institute of India, P.O. Box 18, Chandrabani, Dehradun 248001, India*
[2]*WWF-India, Lodhi Estate, New Delhi-110003, India*

Abstract: In the North Bilaspur Forest Division in Madhya Pradesh, India, the sloth bear (*Melursus ursinus*) population is ecologically isolated, and some bears have developed aggressive behavior. Available bear habitat is highly fragmented and degraded and is interspersed with human habitation. In this study we assessed habitat use patterns of sloth bears with the goal of establishing management guidelines to reduce human–bear conflicts. Goodness-of-fit comparisons showed that expected use of each habitat category differed from habitat availability. Bear sign was most frequent in sal forest followed by land near water, sal mixed forest, and mixed forest. However, bear use of terrain categories was not different from expected use. A large number of bear dens were near water and human settlements. Bears regularly used more than 50% of observed den sites. Because of nearness to human settlement and degraded habitat, bears largely depended on villages for food, resulting in frequent human–bear encounters, some of which led to maulings and fatalities. One management priority is to protect highly preferred habitats of sloth bears. Bear population control and translocation of bears from isolated habitat patches to more suitable areas may be carried out simultaneously with education and awareness programs to conserve this species and to mitigate human–bear conflicts on a long-term basis.

Key words: bear sign, denning habitat, fruit trees, habitat use, human–bear encounters, *Melursus ursinus*, sloth bear

Ursus 15(2):203–211 (2004)

The quality of sloth bear habitat is determined by availability and seasonal variation in food, shelter, and vegetation cover. The availability of fruiting trees, shrub densities, water, and termites and ants directly influence habitat use. Despite myrmecophagous habits (Davidar 1983, Swenson et al. 1999), sloth bears are omnivorous and consume large amounts of vegetable matter, particularly fruits (Laurie and Seidensticker 1977; Gopal 1991; Gokula 1991, Gokula and Vardharajan 1995). Studies of movement patterns of sloth bears showed that home-range size mainly depended on food supply (Joshi et al. 1995, Desai et al. 1997).

Depletion and fragmentation of natural forest cover because of human development and agricultural practices have greatly impacted movements and habitat use of sloth bears throughout their range (Sankar and Murthy 1995, Rajpurohit and Krausman 2000). North Bilaspur Forest Division records showed 395 incidents of human fatalities or injuries from bear attacks between 1991 and 2000. Loss and degradation of habitat have been major factors behind human–bear conflicts in the North Bilaspur Forest Division (Bargali 2002).

Little information is available on denning, movement patterns, and habitat use of sloth bears in disturbed and fragmented forest areas. Such information may be helpful to forest managers to gain a better understanding of resources on which sloth bears depend. Our study was designed to assess habitat use patterns of sloth bears in North Bilaspur Forest Division, where bear habitat is highly disturbed and fragmented.

Study area

This study was conducted during 1998–2000 in the Pendra and Marwahi ranges of the North Bilaspur Forest Division, Madhya Pradesh, covering an area of 1,395 km^2 (Fig. 1). The study area was between 22°40′ and 23°06′ N latitude and 81°44′ and 82°13′ E longitude. Based on satellite images of the North Bilaspur Forest Division, human settlement and agricultural land

[3]nay_in@yahoo.com
[4]hsbargali@rediffmail.com
[5]npsc@wii.gov.in

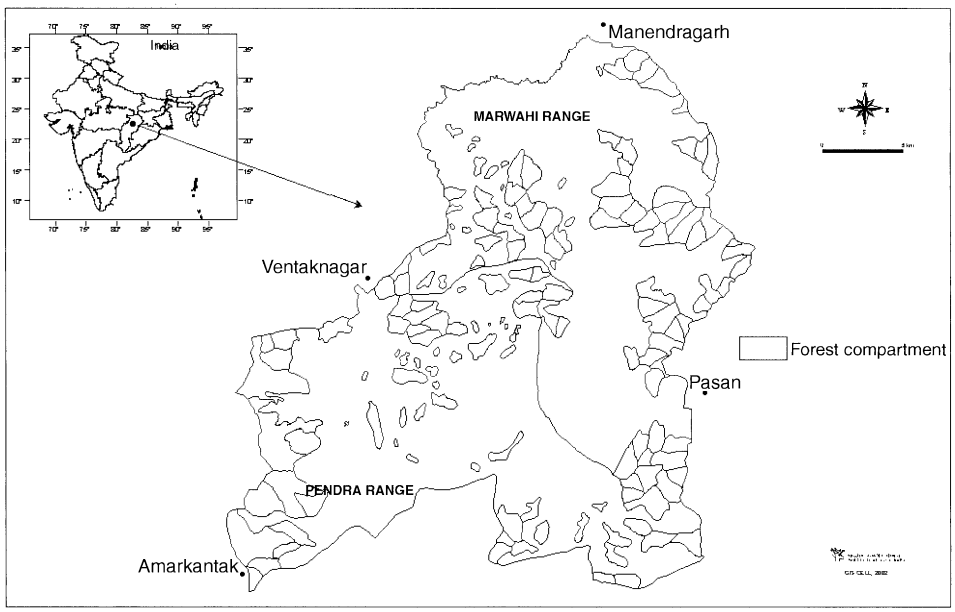

Fig. 1. Sloth bear study area in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

occupied approximately 60% of the study area (Akhtar 2002). About 380 km^2 of the study area was forested (Fig. 2). The human population exceeded 200,000, and the livestock population was over 150,000. Forest patches ranged from 11 to 97 ha. Most forest patches were interspersed among or surrounded by human settlement and agricultural lands.

The study area is in one of the oldest mountain chains of India. The area is within the Eastern Deccan Biogeographical Zone (Rodgers and Panwar 1988). Agricultural soils are mostly clay and loam. The topography of the Vindhya or Maikal range is undulating and interspersed with chains of hillocks and rocks ranging in elevation from 450–1,050 m. Some hillocks are isolated and surrounded by villages. One major river, the Son, flows through the area, and nullas (seasonal streams) originate from hillocks. Drinking water comes from ponds and check dams throughout the study area. Mean day temperatures vary little during December to February (24.5° C and 27.1° C). However, temperatures during winter nights average 10.7° C but drop as low as 2° C. Average rainfall in the region is 1,376 mm, of which 85% occur during the monsoon. Man-made ground fire is common during summer months.

Champion and Seth (1968) classified the forest types of the area as dry deciduous peninsular sal forest, northern tropical dry mixed deciduous forest, and northern tropical secondary moist mixed deciduous forest. In addition to sloth bears, other large mammals in this area include common leopard (*Panthera pardus*), nilgai (*Boselaphus tragocamelus*), spotted deer (*Axis axis*), striped hyena (*Hyaena hyaena*), golden jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), four-horned antelope (*Tetracerus quadricornis*), wild boar (*Sus scrofa*), common langur (*Semnopithecus entellus*), rhesus macaque (*Macaca mulatta*), toddy cat or palm civet (*Paradoxurus hermaphroditus*), and Indian porcupine (*Hystrix indica*).

Methods

Surveys were conducted within the Pendra and Marwahi ranges of North Bilaspur Forest Division to determine habitat use (i.e., sloth bear sign) and habitat availability. Linear transects were placed within the study area, covering all areas we deemed representative of bear use, such as forests, denning habitats, and crop fields. Two transects were placed specifically along nullas and rivers because bears are known to use these areas. Data collected within the same habitat type were pooled. Seventy-eight linear transects of 1 km each were placed in 8 habitat types: mixed forest, sal forest, sal mixed forest, crop field, scrub land, open land, land near water, and plantation. Transect surveys were conducted 4 times at intervals of three months during the first year.

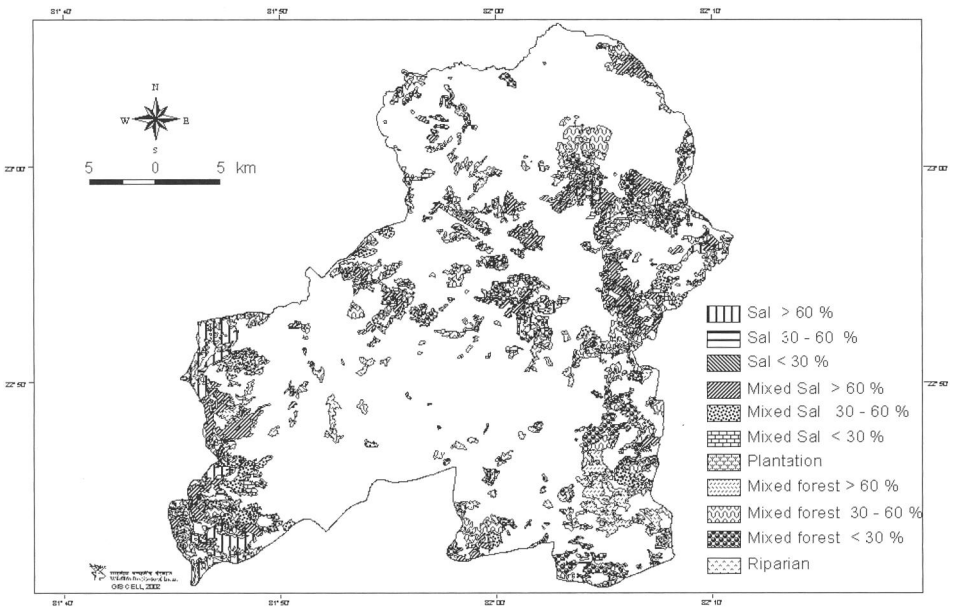

Fig. 2. Forest cover in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

Bear sign was recorded within 5 m of either side of each transect. Along each transect, we also established sample plots every 250 m (5 plots per transect). Each circular plot had a 10-m radius. We recorded presence or absence of bear sign, including diggings, scats, and claw marks. We also recorded information on habitat variables including terrain, vegetation type, tree and shrubs species (Cottam and Curtis 1956), number of cut and lopped (cutting of branches for fuel or fodder) trees, tree height, canopy cover, presence of cattle dung, and termite mounds. At the same plot, we also recorded distance to nearest water source, distance to nearest denning habitat, distance to nearest human habitation, and distance to nearest road. Terrain was divided into 4 broad categories: flat, undulating, gentle, and steeply sloped. Tree canopy cover and tree height were measured with a densiometer and a range measuring system, respectively. The density of fruiting trees near villages was estimated using a plotless sampling method (nearest 10-tree method; Kent and Coker 1992). Scats found at bear dens and sampling plots along transects were collected. Scats were washed and food items were identified, mostly by ocular and microscopic examination. Almost all items in the sloth bear scats, including ants and termites, could be identified in the field or laboratory. Types of fruits eaten by bears were determined from analysis of 1,086 scats.

We compared habitat use of sloth bears with habitat availability (Neu et al. 1974) using the software program *PREFER* (Gupta and Prasad 1992). We tested the hypothesis that bears used the 8 habitat types in proportion to occurrence within the study area. The frequency of bear sign in each habitat type was used to determine bear habitat use. Availability of each habitat type in the study area was based on sampling of 390 plots.

We determined associations among the habitat variables by constructing a dissimilarities table (a symmetric matrix) and plotting the results in 2 dimensions with SPSS (Version 8.0; Norussis 1994). Variables associated with vegetation cover (canopy, tree species richness, fruiting tree species richness, tree height, shrub cover, and herb cover), human influence (felled and lopped trees, disturbance from road, and presence of cattle dung), availability of food (termite mounds), village distance, and distances to nearest water sources and denning habitat were used in the scaling. We used the Kruskal-Wallis test (Zar 1984) for differences among habitat variables in plots with and without bear sign. For this analysis, we used information on canopy, terrain, forest type, tree richness, fruiting tree richness, felled and lopped trees, tree height, distance to nearest habitation, disturbance from road, cattle dung, distance to nearest water sources, distance to nearest denning habitat, shrub cover, and herb cover.

Finally, we collected information on bear den locations and other bear observations, including human–bear encounters. Because most of the area was

Table 1. Sloth bear habitat use and habitat availability in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

Habitat type	Proportional availability	Plots	Plots with bear sign	Use (%)	Expected use (%)	Dug-out mounds/ha	Scats/ha
Mixed forest	0.292	114	55	48.2	52.6	17.1	3.6
Sal forest	0.138	54	38	70.4	24.9	36.0	3.2
Sal mixed forest	0.141	55	28	50.9	25.4	17.4	0.6
Crop field	0.064	25	7	28.0	11.5	7.2	1.7
Scrub land	0.226	88	28	31.8	40.6	9.9	1.3
Open land	0.064	25	7	28.0	11.5	7.6	3.4
Land near water	0.038	15	9	60.0	6.9	18.4	2.1
Plantation	0.036	14	8	57.1	6.5	9.9	0
Total		390	180				

interspersed with human settlement, we first collected information regarding bear dens and bear observations from villagers. We subsequently visited the entire study area with local field assistants and villagers to confirm the existence of dens based on the presence or absence of scats. Bears are basically nocturnal here, and use hollow cavities between boulders of a hillock to spend daytimes; we commonly refer to these as "dens". One small hillock may hold a single den site with multiple openings and compartments, whereas a large hillock might have more than one den site. We monitored all these potential bear denning sites during 500 visits over 3 years. Villagers residing adjacent to den sites also provided information on bear activity at those sites. Many of the den sites were specifically observed to record denning activity of bears.

Results

Habitat use

Data collected from the 390 sample plots indicated that most of the available habitat was mixed forest (29.2%) and scrub land (22.6%), whereas plantations represented the least available habitat type (Table 1). Goodness-of-fit test showed that bear use of each habitat category differed from the occurrence of habitat categories within the study area ($\chi^2 = 15.71$, 7 df, $P = 0.050$). Occurrence of bear sign was high in sal forest, followed by land near water bodies, plantation, mixed forest, and mixed forest; agricultural fields received the least use.

Chi-square tests indicated that bear use of each terrain category (flat, undulating, gentle and steep slope) did not differ from its proportional occurrence ($\chi^2 = 1.27$, 3 df, $P = 0.500$). However, den sites primarily occurred on gentle to steep slopes of hillocks, although a few temporary dens were found along rivers during summer.

Termites are a common, preferred food item of sloth bears. We observed two types of termite nests: underground nests, which were difficult to detect, and prominent mounds from 20 to 500 cm in height. Although we found the greatest density of termite mounds near water and on plantation areas, these habitats covered a small area (Fig. 3). Average density of termite mounds across all habitat types was 16.4 mounds/ha. Along nullas and river banks, we frequently found termite mounds that had been dug out by bears. Although underground termite nests were numerous along water bodies, the colonies were relatively small and bears seemed to prefer feeding on termites in mounds. Once dug out by bears, termites were not eliminated completely; termites recovered very quickly and built their nests again. The number of diggings was greatest in sal forest (Table 1).

Two-dimensional scaling of the habitat variables showed that bear sign was most abundant in areas at larger distances from villages and den sites, where vegetation cover and availability of food was relatively high. Habitats that were most frequently used by bears received relatively high human disturbance (e.g., cut trees, lopped trees, cattle grazing; Fig. 4). Except for terrain, herb cover, and distance from water, all other habitat variables (tree canopy, forest type, tree richness, fruiting tree richness, felled trees, lopped trees, tree height, cattle grazing, shrub cover, distance from habitation, road and denning habitat) differed between areas where bear sign was present versus areas without bear sign.

Food availability and food habits

Among 390 plots, 147 (37.7%) lacked fruiting species. For all plots combined, the average density of fruit trees was estimated at 38/ha, with greatest densities in sal mixed forest. Fruit trees comprised 19% of the

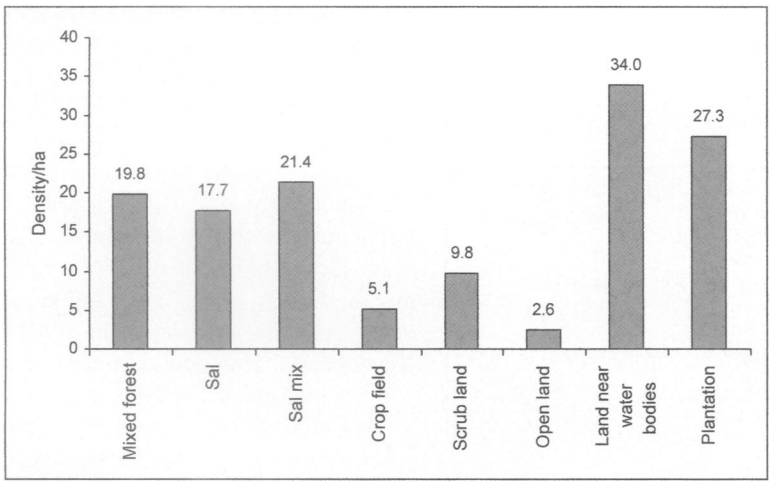

Fig. 3. Density of termite mounds by habitat type in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

overall tree density (202/ha) in the study area (Table 2). Average fruiting tree density near villages was approximately 5/ha.

The average density of fruiting shrubs was estimated at 727/ha across all habitat types (Table 3). Maximum density of fruiting shrubs was found in sal mixed forest (1,279/ha). Sal mixed forest, sal forest, and mixed forest with high densities of both fruiting trees and shrubs also had the highest densities of bear sign (diggings and scats).

A total of 30 different food items were found in scats ($n = 1,086$). Fruits of gular (*Ficus racemosa*), pakri (*F. virens*), bargad (*F. benghalensis*), peepal (*F. religiosa*), ber (*Ziziphus mauritiana*), bel (*Aegle marmelos*), jamun (*Syzygium cumini*), and mahua (*Madhuca indica*), in addition to termites (*Odontotermes obesus*) and ants were major food items for sloth bears. Of all fruiting shrub species, only 2, makoiya (*Ziziphus oenoplia*) and jangli ber (*Z. nummularia*), were important in the bear diet. Both occurred exclusively in forests; makoiya was mainly found in mixed forest and scrub land, whereas jangli ber was found in plantations, sal mixed forest, land near water, and mixed forest. Seventeen food items of bears were found in both forests and villages; only 7 and 6 food items were confined to forests and villages, respectively.

Den sites

We identified 109 den sites in the study area. Of those sites, 51% were used regularly. More than 96% of the den sites were located <1,250 m of human habitation (Table 4). Generally, the number and size of dens corresponded to the size of hillock. Most den sites were located in large (150–300 m long and 50–80 m wide) hillocks. Large boulders of hillocks also sheltered other animals. Leopards, hyenas, jackals, and sloth bears all used a den site near the village of Tauli, with no apparent competition.

Water for bears was plentiful, and approximately 77% of the den sites had water within 500 m (Table 5). However, at many areas, we also observed holes in the river sand dug by bears for drinking water.

Human–bear encounters

Human–bear encounters that resulted in human injuries or fatalities were documented from 1991 to 2000 ($n = 395$). Of 178 villages, 122 reported human–bear incidents. Incidences of mauling occurred most frequently (93.7%), but human fatalities were not uncommon (6.3%). Such incidents were less common in the Pendra range (27.3 %, $n = 108$) than the Marwahi range 72.7% ($n = 287$). Most of the incidents occurred as people collected non-timber forest products (31.0%), followed by traveling through the forest (28.1%), cattle grazing (24.3%), fuel wood collecting (11.9%), and defecation near backyard (4.8%). In both ranges, incidences of bear encounters were greatest for men (70.6%, $n = 279$), followed by women (18.7%, $n = 74$), and children (4.3%, $n = 17$). Most bear encounters occurred between 0600–0800 hours (20.3%), followed by incidents between 0400–0600 hours (18.0%), 1000–1200 hours (17.5%), 0800–1000 hours (17.2%), 1400–1600 hours (6.8%), 1800–2000 hours (6.6%), and 1600–1800 hours (5.3%). Most incidents occurred in forests (53.2%), followed by crop fields (26.3%), and villages (20.5%).

Discussion

In the Pendra and Marwahi ranges of North Bilaspur Forest Division, forests are highly disturbed and fragmented by human habitation and agricultural land. There is continuous encroachment on forest land, collection of fuel wood and non-timber forest products, livestock grazing, and stone mining. As a result, the sloth bear population has become fragmented. These anthropogenic influences may have adversely affected

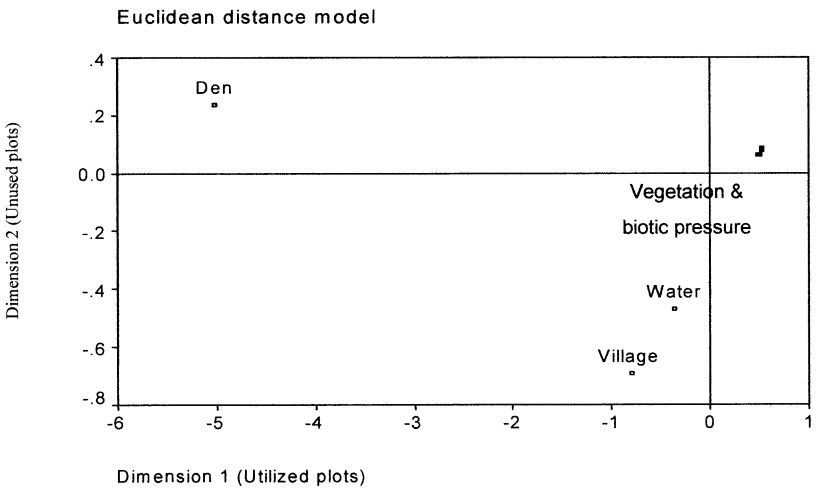

Fig. 4. Two-dimensional scaling of habitat variables in plots used and not used by sloth bears in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

habitat use and movement patterns of sloth bears in the area.

In Chitwan National Park in Nepal, the density of termite mounds in upland sal forests was greater than alluvial flood plains (Joshi et al. 1995). In the Pendra and Marwahi ranges, the maximum density of termite mounds occurred near water, followed by plantations, sal mixed forest, mixed forests, and sal forest. Termite mounds dug by bears likely were more common in areas near water because of the large number of underground termite mounds in soft soil, which facilitates digging. Overall, most bear sign was found in sal forest habitat followed by land near water, sal mixed forest, and mixed forest, because of high fruiting trees and availability of termites mounds. Compared with the dry deciduous sal and mixed forests of the North Bilaspur Forest Division, sloth bear habitat was different in the Mudumalai Wildlife Sanctuary, India, where bears most frequently used dry deciduous tall grass forest, followed by dry deciduous short grass, thorn forest, and moist deciduous forest (Desai et al. 1997). Nevertheless, bears found fruiting trees and termite mounds in both areas.

The high density of fruiting tree species in sal mixed forest, sal forest, and mixed forest may attract bears to these vegetation types. Trunks of fruiting trees in both ranges had claw marks of sloth bears. Based on the examination of scats, the fruits of two shrubs, *Ziziphus oenoplia* and *Ziziphus nummularia*, seemed to be preferred by sloth bears. Manjrekar (1989) found that Asiatic black bears in Dachigam National Park in India also mainly depended on fruits (e.g., *Prunus avium*, *Morus alba*, *Quercus robur*, *Juglans regia*) resulting in extensive use of forest habitats. However, in our study area, fruiting trees in the forested areas predominantly were in early age classes with a relatively low fruit supply. Consequently, during the winter and monsoon seasons, bears were attracted to crop fields near villages because of the availability of ber (*Ziziphus mauritiana*), corn, and ground nut (*Arachis hypogaea*). Frequent bear use of such areas may be one

Table 2. Fruiting tree density (trees/ha) by habitat types in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

Tree species	Mix forest	Sal forest	Sal mixed forest	Crop field	Scrub land	Land near water bodies	Plantation
Cassia fistula	2.0	0.6	1.2		2.2	2.1	
Anona squamosa	2.2				0.4		
Ficus benghalensis	0.3						
Aegle marmelos	0.8				1.1		
Buchanania lanzan	12.9	24.8	24.3	1.3	3.6	2.1	2.3
Ficus racemosa	0.3					8.5	
Syzygium cumini	1.4	2.7	0.6		1.1	6.4	
Schleichera oleosa	3.1		2.3		1.8		
Madhuca indica	12.0	14.7	26.1	6.4	2.2	6.4	
Ficus virens	0.3	1.1			2.9		
Ficus religiosa	0.3		0.6		0.4		
Diospyros melanoxylon	19.6	16.5	17.4		9.8	1.6	
Mangifera indica			0.6		1.1		2.3
Total	55.2	60.4	73.1	7.6	26.4	36.1	4.6

Table 3. Fruiting shrub density (shrubs/ha) in different habitat types in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

Species	Mixed forest	Sal forest	Sal mix forest	Crop field	Scrub land	Open land	Land near water bodies	Plantation
Anona squamosa	27.9		32.4		2.3	15.3		18.2
Cassia fistula	7.8	2.4			5.8			
Aegle marmelos	5.6		2.3		11.6			9.1
Ziziphus nummularia	15.6	23.6	67.2	5.1	1		42.5	19.2
Buchanania lanzan	12.3	96.7	46.3		4.3		42.5	
Syzygium cumini	4.5	11.8	4.6		3		17	18.2
Briedelia squamosa	22.4	11.8	64.9		4.3		8.5	9.1
Diospyros malabarica	2.2							
Ziziphus oenoplia	1.1				1.5			
Ficus virens	1.1							
Mimusops elengi	1.1		25.5					
Diospyros melanoxylon	783.3	82.1	133	122.3	668.8	795	424.6	39.4
Schleichera oleosa			2.32		5.8			
Psidium guajava							8.5	
Ficus racemosa							17	
Total	884.9	948.4	1,278.5	127.4	735.4	810.3	560.6	473.2

of the major reasons for the increasing number of encounters with humans near villages.

In the Mudumalai wildlife sanctuary, sloth bear dens were located in nullas and rocky outcrops (Desai et al. 1997). In the Pendra and Marwahi ranges, however, sloth bears exclusively used rocky outcrops with large boulders for denning. We never found bears digging dens in stream beds, nullas, or other habitats. In our study area, people gather rain water using traditional methods by digging ponds and constructing stop dams. Therefore, many ponds and other water bodies were available throughout the area. Vegetation cover did not seem to influence use of den sites by sloth bears in Mudumalai wildlife sanctuary. Similarly, sloth bears in our study area used hillocks, both with and without vegetation cover, although most den sites had moderate to dense vegetation surrounding them.

In the Pendra and Marwahi ranges, sloth bear populations were not evenly distributed. Of all potential den sites identified across the study area ($n = 109$), 65 were in the Marwahi range. In the Pendra range, 41% of the den sites were actively used by bears, compared with 59% in the Marwahi range. Because of the presence of numerous den sites, the Marwahi range likely has greater bear densities than the Pendra range, which may explain the greater number of bear attacks in the Marwahi range. Generally, men were most vulnerable to bear attacks because they are involved in the collection of non-timber forest products and livestock grazing. Those activities are concentrated during early morning hours, when most human–bear incidents seemed to occur.

We attribute uneven distribution and non-occupancy of some areas to the lack of suitable habitats and denning areas and to the isolation of habitat patches. In Tangjiahe Nature Reserve, China, Asiatic black bears (*Ursus thibetanus*) exhibited distinct range shifts in early autumn to obtain mast at lower elevations (Reid et al. 1991). Among grizzly bears (*U. arctos*), spacing was found to be related to distribution of food resources (Servheen 1983). Similar observations were made by Joshi et al. (1995) for sloth bears in Royal Chitwan National Park, Nepal, where bears showed shifts from alluvium habitat to upland sal forest.

Conservation of bear habitat

Bear habitats and denning areas in the Pendra and Marwahi ranges, including Lityasarai, Marakot, and

Table 4. Frequency of sloth bear dens among distance classes to nearest village in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

Distance from habitation (m)	Active dens	Temporary dens[a]	Total dens
0–250	12	15	27
250–500	18	9	27
500–750	6	5	11
750–1,000	3	5	8
1,000–1, 250	13	10	23
1,250–1,500	1	2	3
1,500–1,750	1	5	6
1,750–2,000	0	0	0
2,000–2,250	2	2	4
Total	56	53	109

[a]Temporary dens were used by bears only occasionally.

Table 5. Frequency of sloth bear dens among distance classes to nearest water in the North Bilaspur Forest Division, Madhya Pradesh, India, 1998–2000.

Distance (m)	Dens
0–250	62
250–500	22
500–750	6
750–1,000	4
1,000–1,250	11
1,250–1,500	0
1,500–1,750	4

Karangara forest areas, have been increasingly encroached upon by villagers for crop cultivation. That encroachment is one of the primary conservation issues for sloth bears in this region. Protection of contiguous and undisturbed sal forest, sal mixed forest, mixed forest, rocky outcrops, and scrub forest will be important to maintain sloth bears in the areas. Villagers also increasingly remove or cut fruit trees (e.g., *Ziziphus mauritiana*) near villages that provide important foods for sloth bears. Thus, there is a need for education and awareness among the villagers about the significance of these trees for bears, feeding habits of bears, and living in harmony with bears. Villagers also collect flowers and fruits of *Madhuca indica*, *Aegle marmelos*, *Buchanania lanzan*, *Ziziphus mauritiana*, and *Z. nummularia*, which are important food items of sloth bears. A ban on collection of these items may need to be considered. Our data on human–bear conflicts indicated that most encounters occurred during morning hours when villagers graze their cattle and collect forest products. The data from our study may be used to inform villagers about bear ecology; with that information villagers may learn how to avoid bear activity periods and minimize disturbances in bear habitat.

There are many isolated denning areas in the Pendra (e.g., Barbasan, Tauli, Surungtola) and Marwahi ranges (e.g., Katra, Karhaniya) that are surrounded by human settlement and agricultural fields. Translocation of bears from those areas to areas with more contiguous habitats may provide a strategy to control bear population increase, thereby mitigating human–bear conflicts in the long term.

Acknowledgments

We are grateful to the Director of the Wildlife Institute of India, Dehradun, for giving us an opportunity to work for this highly prestigious institute, and for the opportunity to work on sloth bears. We are very thankful to the Madhya Pradesh Forest department for providing permission for research and for tremendous support and cooperation. We are also thankful to field assistants P. Singh and Kamlesh, who spent their sweat and blood with us for successful completion of this project. We are grateful to F. van Manen and 2 other referees for improving this manuscript. We acknowledge C. Sharma and R.P. Pandey, Lecturer in District Institute of Teaching and Education, and their family members for providing great hospitality and love during the stay at Pendra.

Literature cited

AKHTAR, N. 2002. Habitat use, ranging pattern and management of sloth bear (*Melursus urcinus*) in North Bilaspur Forest Division, Madhya Pradesh. Dissertation, Saurastra University Rajkot for Wildlife Institute of India, Dehradun, India.

BARGALI, H.S. 2002. The ecology of the problematic sloth bear (*Melursus urcinus*) and mitigation of human–bear conflicts in Bilaspur Forest Division, Madhya Pradesh. Dissertation, Saurastra University Rajkot for Wildlife Institute of India, Dehradun, India.

CHAMPION, H.B., AND S.K. SETH. 1968. A revised survey of forest types of India. National Book Trust of India, New Delhi, India.

COTTAM, G., AND J.T. CURTIS. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451–460.

DAVIDAR, E.R.C. 1983. Sloth bear's (*Melursus ursinus*) method of hunting for termite nests. Bombay Natural History Society 80:637.

DESAI, A.A., N. BHASKARAN, AND S. VENKATESH. 1997. Behavioural ecology of the sloth bear in Mudumalai Wildlife Sanctuary and National Park. Report. Tamil Nadu and Bombay Natural History Society collaborative project. Bombay Natural History Society, Mumbai, India.

GOKULA, V. 1991. Some aspects on the feeding habits of the sloth bear (*Melursus ursinus*) at Mundanthurai Wildlife Sanctuary, Tamilnadu (South India). Thesis, A.V.C. College, Mannambandal Tamil Nadu, India.

———, AND M. VARDHARAJAN. 1995. Food habits of sloth bear (*Melursus ursinus*) on Mundanthurai plateau, Tamil Nadu, India. Tiger Paper January–March:13–15.

GOPAL, R. 1991. Ethological observation on the sloth bear (*Melursus ursinus*). Indian Forester 975:920.

GUPTA, N., AND S.N. PRASAD. 1992. PREFER-BASIC programme for analysis of habitat preferences of animals. Wildlife Institute of India, Dehradun, India.

JOSHI, A.R., D.L. GARSHELIS, AND J.L.D. SMITH. 1995. Home range of sloth bears in Nepal. Implication for conservation. Wildlife Management 59(2):204–214.

KENT, M., AND P. COKER. 1992. Vegetation description and analysis: A practical approach. Belhaven, London, UK.

LAURIE, A., AND J. SEIDENSTICKER. 1977. Behavioural ecology of the sloth bear (*Melursus ursinus*). Journal of Zoology (London) 182:187–204.

MANJREKAR, N. 1989. Feeding ecology of the Himalayan black bear (*Selenarctos thibetanus*) in Dachigam National Park. Thesis, Wildlife Institute of India, Dehradun, India.

NEU, C.W., C.R. BYERS, AND J.M. PEEK. 1974. A technique for analysis of utilization—availability data. Journal of Wildlife Management 38:541–545.

NORUSSIS, M.J. 1994. SPSS/PC + statistical data analysis. SPSS Inc., Chicago, Illinois, USA.

RAJPUROHIT, K.S., AND P.R. KRAUSMAN. 2000. Human–sloth bear conflicts in Madhya Pradesh, India. Wildlife Society Bulletin 28:393–399.

REID, D., M. JIANG, Q. TENG, Z. QIN, AND J. HU. 1991. Ecology of the Asiatic black bear in Sichuan, China. Mammalia 55(2):221–237.

RODGERS, W.A., AND H.S. PANWAR. 1988. Planning a wildlife protected area network in India. Wildlife Institute of India, Dehradun, India.

SANKAR, K., AND R.S. MURTHY. 1995. Assessment of bear–man conflict in North Bilaspur Forest Division, Bilaspur, Madhya Pradesh. Report, Wildlife Institute of India, Dehradun, India.

SERVHEEN, C. 1983. Grizzly bear food habits movement and habitat selection in the mission mountains, Montana. Journal of Wildlife Management 47:1026–1035.

SWENSON, J.E., A. JANSSON, R. RIIG, AND F. SANDEGREN. 1999. Bears and ants: myrmecophagy by brown bears in central Scandinavia. Canadian Journal of Zoology 77:551–561.

ZAR, J.H. 1984. Non parametric anova. Biostatistical analysis. Second edition, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA.

Received: 30 July 2002
Accepted: 10 January 2004
Associate Editor: F. van Manen