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SLOTH BEAR (*MELURSUS URSINUS*) HABITAT IN THE FORESTS OF NORTH BILASPUR FOREST DIVISION, CHHATTISGARH

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ABSTRACT

The practical way of identifying potential habitat of a species is to have a thorough examination of land use patterns (e.g. natural forests, plantations, water bodies, road network, human habitations, etc.) in an area from the remotely-sensed data. The framework of a species habitat suitable model also envisage to ascertain features such as compact forest blocks especially those along the courses of the least fragmentation, smallest stretches of discontinuity and of the adjacent poorly covered forests communicating with the large blocks for gene flow and terrain, availability of forage and water in such areas specifically, during dry season and its distance from the human habitations with a view to ascertain its amenability to revival besides least biotic interferences. We, therefore, incorporated all such variables into our habitat suitability model for sloth bear (*Melursus ursinus*). A statistically desirable proportion of sloth bear geographic locations based on direct sightings during the course of study were randomly selected and were laid over the spatial layers so as to generate potential available habitat for sloth in North Bilaspur Forest Division. Logistic regression model was used to develop the probability distribution map.

Key words: Sloth bear, Habitat Model, North Bilaspur, Remote-sensing and Geographical Information System.

Introduction

Conventional methods have been used for a long time to evaluate the habitat using various indices (Lamprey, 1963; Panwar, 1972; Giles, 1978; Kotwal and Parihar, 1988). However, a model can be derived from different combinations of the controlling factors identified from a Geographic Information System (GIS) database to predict suitability of a particular habitat. A number of studies have used GIS to handle multilayered spatial and tabular data to analyse animal habitats (Roy *et al.,* 1995; Porwal *et al.,* 1996).

Sloth bear (*Melursus ursinus*) is endemic to low altitudinal areas of Indian Subcontinent and listed as Schedule 1 under the aegis of Indian Wildlife Protection Act 1972 and is under Appendix I of CITES and vulnerable in IUCN red list category. Sloth bears are distributed from north to south and east to west in India except some north-eastern states and desert areas of western India (Preter, 1971). Joshi *et al.* (1995) studied ecology and behaviour of sloth bear in Nepal. Others (e.g. Jerdon, 1874; Sterndale, 1884; Fletcher, 1911; Laurie and Seidensticker, 1977; Sunquist, 1982; Baskaran *et al.,* 1997) had written anecdotal notes on habitat use, food habit, activity patterns and behaviour of sloth bear. However, no study so far has been conducted to quantify available sloth bear habitat across its distributional range. This information is important for monitoring status of globally vulnerable sloth bear with respect to assessing its future survival prospects in accordance with threat assessment criteria. In addition, the knowledge on habitat of a species is desirable in developing its conservation action plans - be they at global or regional or local level(s). Therefore, we aimed to quantify and document available sloth bear habitat across the forests of North Bilaspur Forest Division and associated anthropogenic disturbances therein so as "Satellitic Mini Core" units of largely compact units of large compact forest blocks situated along the courses of least fragmentation could be identified and incorporated into local management plan for long-term survival of the species in general and other associated fauna in particular.

Material and Methods

Study Area

The habitat of sloth bear was quantified in between 81°45'& 82°13' E longitude and 22°09' & 23°7' N latitude in Pendra and Marwahi ranges under North Bilaspur Forest Division of Chhattisgarh during 1998 and 2000 (Figure 1). There existed 178 villages harbouring 1.8 lakh human and 1.5 lakh cattle population.

Suitable sloth bear habitat model is suggested in a conflict affected degraded habitat using Geographical Information System.

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Topographically, the study area covers Chhattisgarh Plains and parts of Maikal Hills. Ecologically, the area is a part of the Eastern Deccan Bio-geographical Zone (Rodgers and Panwar, 1988). Champion and Seth (1968) had classified the forest of Bilaspur as Dry Deciduous Peninsular Sal Forest, Northern Tropical Dry Mixed Deciduous Forest and Northern Tropical Secondary Moist Mixed Deciduous Forest. Incidences of ground fire are quite frequent during summer months. In addition to sloth bears, Indian leopard (*Panthera pardus*), spotted deer (*Cervus axis*), striped hyena (*Hyaena hyaena*), jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), four-horned antelope (*Tetracerus quadricornis*), Wild pig (*Sus scrofa*), common langur (*Semnopithecus entellus*), rhesus macaque (*Macaca mulatta*), toddy cat (*Paradoxurus hermaphroditus*) and Indian porcupine (*Hystrix indica*) are important mammals inhabit these forests.

Methods

The Survey of India Toposheets (E/16, F/13, F/14, I/4, J/1 and J/2) at 1 : 50,000 scale were scanned to extract spatial features such as drainage networks, human habitations, forest boundaries, terrain, and road networks on *AO Scale CAD Image Software* (ESRI, 1997a). The digital Indian Remote Sensing Satellite-1B linear imaging (IRS-1B LISS 2B) false colour composite was used to identify major land use/ land cover types. The geo-referenced remotely sensed data was transferred into a standard *map projection* for referencing it to common cartographic co-ordinates. The edge / spatial enhancement techniques were applied to enhance geo-referenced raster image in order to improve visual perception and interpretability of the remotely sensed data.

Thereafter, raster image was classified into major land use / land cover types using unsupervised classification scheme of ERDAS Imagine Software (ERDAS 1997). During unsupervised classification, the programme classified the image into several assigned classes. When topographic map was overlaid onto the image with the classes, the feature like forest, agriculture, roads, human habitations and open areas could be determined easily. Based on unique pixal values, forest vegetation was identified and classified into major vegetation communities (e.g. sal forest, mixed sal forest, scrub and open forests, plantations and miscellaneous forest). The classes under each land use / land cover / vegetation category were verified in the field during ground truth. Training fields representing each land use / land cover/ vegetation type were identified in the image for the purpose. Ground truth data were used

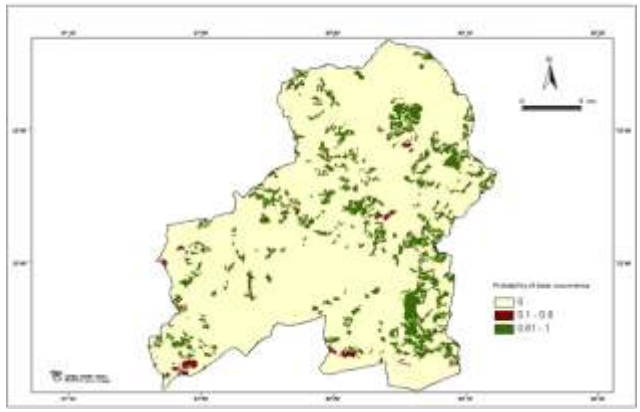

Fig. 1 : Modelling probability of sloth bear distribution in NBFD.

to define regions of interests in the classified image. This information was used to reclassify the image using Maximum Likelihood Classifier Parametric Rule of Supervised Classification (ERDAS, 1997). The supervised classification image produced a clearer and better picture of the study area. The contours were used to generate digital elevation model (DEM). The DEM was normalized and the slope was derived.

To develop the model, 100 geographic location of sloth bear were selected randomly from its 1920 field location recordings during the course of study. In addition, 100 random location points were generated. Actual bear presence was weighted as 1 and random as 0. These points were merged to generate bear location points to be used as dependent variable for logistic regression. Euclidean distance was calculated for dens and villages.

Thus, land use / land cover/ vegetation maps of the study area were generated. Area percentage and proportion of each land use type / land cover type/ vegetation type was worked out using *ARC/INFO Software*. The input coverages were transferred into a standard Map Projection for referencing them to common cartographic co-ordinate system (ESRI, 1996a). All identified vegetation types were weighted 1 for presence and 0 for absence of bear in them. Sloth bear den sites were also scanned in the study area during the course of study and their geographic co-ordinates were recorded. These locations were later marked on the vegetation maps to be used as a separate spatial data layer for identification of potential habitat in the GIS domain. The spatial data generated was used as input coverage for analysis in ARC/INFO Software (ESRI, 1997b; 1997c). Logistic regression was used to develop the probability distribution map. The maps produced so were overlaid and combined together using Union on Arc View Software (ESRI, 1996b) in order to identify suitable sloth bear habitats. The following equations were used to

identify suitable habitat or probability distribution map of sloth bear.

$$Prob(event) = 1/1+e^{-z}$$

Where Z is the linear combination.

$$Z = B_0 + B_1X_1 + B_2X_2 + ... + B_PX_P$$

Where B_0 and B_1 are coefficient estimated from the data, X is the independent variable and e is the base of the natural logarithms, approximately 2.718.

Results

A geographical area of 1395.71 km^2 was used to classify major land use/ land cover in North Bilaspur Forest Division (Table 1). Scrub and open forests covered maximum (45.25%) area followed by Human Habitation and Agriculture (29.98%) in the study area. Not surprisingly, the area under woody plantations was the least (0.13%). A significant proportion of geographical area was calculated under miscellaneous forests (13.99%), mixed sal forest (7.76%) and pure sal (2.97%). The maximum accuracy of bear presence was positively correlated with bear dens, pure sal forest and miscellaneous forest (Table 2) and these variables together accounted for 78.62% of Euclidean distance. Thus, we used bear dens, pure sal forests and miscellaneous forests as the basis of habitat suitability model. The model accuracy was further enhanced by removing geographic locations of false absence in areas where probability was greater than 0.67%. This increased model accuracy up to 94.34%. In areas where sloth bear was present, large area was under the highest probability (81 to 100%) of bear occurrence (Table 3). In contrary, we calculated relatively small area in comparison to area with lower probability of bear occurrence (1 to 20%).

Discussion

Four species of bears namely sloth bear (*Ursus ursinus*), Asiatic black bear (*Ursus thibetanus*), Himalayan brown bear (*Ursus arctos*) and Malayan sun bear (*Ursus malayanus*) are found in India. Sloth bear is endemic to the Indian subcontinent and found in India, Sri Lanka, Nepal, and Bhutan (Prater, 1971).

Table 1: Vegetation and land-use categories based on remote sensing data in NBFD.

Vegetation and landuse category	Area (km^2)
Pure Sal Forest	41.53
Mixed Sal Forest	106.87
Scrub and Open Forest	631.53
Plantation	1.83
Miscellaneous Forest	195.39
Habitation and Agriculture	418.56
Total Area	1395.71

Table 2 : Classification of bear presence and absence considering different combinations of parameters for developing probability distribution map

Parameter	Classification (%)
Euclidean distance of bear dens, and villages, Sal Forest, Mixed Sal Forest, Scrub and Open Area, Miscellaneous Forest, Habitation and Agriculture and DEM	78.62
Euclidean distance of bear dens	69.81
Euclidean distance of bear dens and Miscellaneous Forest	76.73
Euclidean distance of bear dens, Mixed Sal Forest and Pure Sal Forest	78.62

Table 3 : Area under different probabilities of bear occurrence in original and enhanced model in NBFD.

% Occurrence	Original Model (km^2)	Enhanced model (km^2)
0	1161.30	1187.31
1-20	54.93	23.25
21-40	9.43	4.51
41-60	7.42	0.75
61-80	8.45	1.18
81-100	154.19	178.72

Evaluation of habitat of a species depends on the knowledge and information about its behaviour, food habits, mating sites, escape cover, etc. (Porwal *et al*., 1996). Previous workers (e.g. Craighead *et al.,* 1982; Smith, 1985; Hamer and Herrero, 1987; Hamilton and Bunnell, 1987; Clevenger *et al.,* 1992; Joshi *et al.,* 1995) observed that food availability governs bear distribution, movement pattern and habitat use However, availability of protective sites (e.g. dens) or escape cover within the bear range may be as important as the availability of food resources. In the present study, we have attempted to consider all such factors that governs spatial distribution of sloth bear.

In North India (Corbett and Rajaji National Park), sloth bear live in moist deciduous sal forests. In Eastern India, they inhabit moist deciduous and semi evergreen Forests. Sloth bear has also been recorded in Nepal and Sri Lanka, have also recoded sloth bear from tropical moist deciduous forests (Laurie and Seidensticker, 1977; Garshelis *et al.,* 1999; Desai *et al.,* 1997; Eisenberg and Lockhart, 1972). Our model (Figure 2) buttressed by field observations suggests that maximum sloth bear habitat is sal and mixed sal on bouldery hillocks in the vicinity of water bodies and agriculture fields in North Bilaspur Forest Division (NBFD). While bouldery hillocks provided safe denning during day time, vicinity of agriculture fields and water body presumably ensured energy requirement of the animal. Our model further shows that available habitat

for sloth bear is patchy and degraded in NBFD Ursids exhibit wide variation in spacing behaviour based on availability of food and protective or escape cover within the bear range and together both of these parameters can maximise fitness of a model (Joshi *et al.,* 1999).

In NBFD, human casualties due to encounter with sloth bear and severe crop damage by sloth bear are the main challenges for its conservation. Bargali (2003) observed bear used to pass over villages to enter into the next available forest patch or crop fields to raid crops or fruiting trees in search of food and water. Presence of bear dens close to human habitation, crop depredation by sloth bear and necessity for bears to pass through villages to forage are among the reasons leading to frequent human mauling and killing by sloth bear in NBFD (Bargali *et al.,* 2004; Bargali *et al.,* 2005). Though model showed most of the area under bear presence is in close proximity to human habitations, yet policy level efforts are required to include potential bear habitat under protected area network system.

उत्तरी बिलासपुर वन प्रभाग, छत्तीसगढ़ के वनों में मन्द रीछ (*मीलूरसस यूर्सिनस*) आवास

एच.एस. बरगाली, नईम अख्तर और एन.पी.एस. चौहान

सारांश

किसी भी प्रजाति के सक्षम आवास की पहचान करने का व्यावहारिक तरीका है कि सुदूरवर्ती-संवेदी आंकड़ों से एक क्षेत्र में भूमि उपयोग पैटर्नों (उदाहरणार्थ- प्राकृतिक वन, रोपण, जल समूह, सड़क नेटवर्क, मानवीय आवास आदि) का समग्र परीक्षण किया जाए। एक प्रजाति आवास उपयुक्त मॉडल की रूपरेखा में सुसंहत वन ब्लाकों विशेषकर वे जो न्यूनतम विखण्डन की दिशा के साथ हैं, असमानता के छोटे खण्ड और जीन प्रवाह एवं भूभाग के लिए विशाल ब्लॉकों के साथ सूचित करने वाले समीपवर्ती कमजोर आच्छादित वनों के, ऐसे क्षेत्रों में विशेषकर शुष्क मौसम के दौरान चारे और पानी की उपलब्धता और न्यूनतम जीवीय हस्तक्षेपों के अलावा पुनरूज्जीवन के लिए इनकी परिचालनीयता का पता लगाने के दृष्टिकोण के साथ मानवीय वास स्थानों से इनकी दूरी जैसे गुणों का पता लगाने पर भी विचार किया गया है। इसलिए हमने मन्द रीछ (*मीलूरसस यूर्सिनस*) के लिए अपने आवास उपयुक्तता मॉडल में इस प्रकार के सभी परिवर्तियों को समाविष्ट किया है। अध्ययन के दौरान प्रत्यक्ष अवलोकन पर आधारित मन्द रीछ भौगोलिक स्थानों का एक सांख्यिकीय रूप से वांछनीय अनुपात बेतरतीब रूप से चयनित किया गया और स्थानिक परतों पर रखा गया ताकि उत्तरी बिलासपुर वन प्रभाग में मन्द रीछ के लिए सक्षम उपलब्ध आवास सृजित किया जा सके। संभाव्यता वितरण मानचित्र विकसित करने के लिए वृद्धिघाती समाश्रयण मॉडल (लौजिष्टिक रीग्रेसन मॉडल) का उपयोग किया गया।

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