

**DEVELOPMENT OF HUMAN BEAR CONFLICT
MITIGATION STRATEGIES THROUGH HABITAT
MANAGEMENT USING GEOSPATIAL TECHNIQUES**

Abstract for Ph.D. Submission

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Abstract

Sloth bears are amongst the large mammalian species found in the Gujarat state (India) that are widely spread towards the eastern border having protected and non-protected forested land. Continuously degradation and fragmentation of these habitats have led the bears towards human dominated landscape in search of basic resources such as food and water. This has led to increase in encounters between the two. With rising attacks on humans, it is being recognised as a potentially dangerous species. Consequently, a requirement to understand ecological requirements and interactions of a species in their natural environment has been recognised to evaluate and develop suitable strategies that can help in reducing such conflict world over. Hence, with the Sloth bear as the focal species, this study was targeted encompassing five protected habitats of sloth bears, Jessore Sloth Bear Sanctuary, Balaram Ambaji Wildlife Sanctuary, Ratanmahal Sloth Bear Sanctuary, Jambhughoda Wildlife Sanctuary and Shoolpaneshwar Wildlife Sanctuary along with the surrounding non-protected habitats in Gujarat. The present work explores three potential approaches which can be utilised as mitigating strategies using advanced tools and software's like Gnarly tools, Linkage mapper, centrality mapper, ArcGIS, R studio, and MaxEnt.

To begin with, a study assessing the dependency of sloth bear's occupancy on natural water resources in the dry deciduous habitats of North Gujarat was conducted, hypothesizing that water resources can be a limiting factor for the bears especially in summers driving them towards human settlement. Using ArcGIS hydrological tools and natural water sources the drainage maps were prepared to identify water availability in these two monsoon dependent sanctuaries. Bear presence signs were recorded in the surrounding of these water resources along with the environmental parameters like elevation, slope, distance to settlements, presence of fruiting tree species preferred by and habitat type in

two different seasons – before and after monsoons. The data collected subsequently analysed statistically using McNemar's test to establish the significance of the variables affecting sloth bear occupancy around these water resources revealing that the sloth bears' signs reduce around the surveyed water resources after monsoon but statistically no significant difference was established in sloth bear's occupancy in two seasons. The results implies that sloth bears move around irrespective of seasons or other variables in the studied area.

In addition to this, the possible areas in Gujarat state, in and around sloth bear habitats were identified for potential interactions between humans and sloth bears. The study utilized the previous conflict records that occurred between the years 2008-2020 in Gujarat as a presence data in MaxEnt (Maximum Entropy Model). The software used predicts the distribution pattern of conflicts using six variables such as protected areas, landuse/landcover patterns, human settlements, road network, human population density and water bodies. A total 169 conflict locations were used as a presence data in studied area. The software was run using default setting with few exceptions like keeping random test percentage at 25% of data for testing whereas 75% for training. Also, K folding, Jackknifing technique and response curves were analysed. The final output generated by the model predicted 88% spatial variability to delineate the areas for potential human bear conflicts in the state. Distance from protected areas inhabited by sloth bears was found to be strongly influencing the results followed by distance to human settlements. The high-risk zones for human bear conflicts were found to be concentrated around the boundaries of protected areas and as expected reduces with increase in distance from the protected areas (i.e. forest-agriculture interface).

Finally, various tools were employed to identify connectivity between the core identified habitats of sloth bears in the state. A buffer zone covering 50 kilometres was included extending into three adjacent states. To identify the connectivity

between these protected habitats, different environmental and anthropogenic variables such as forest cover, landuse landcover patterns, slope, water bodies, roads, rails, settlements, and human bear conflict locations were considered. Resistance score was calculated varying between 0-100 (with no resistance to maximum resistance) using Analytical Hierarchy Process (AHP) for all the variables. This was subjected to Gnarly utilities tools to generate a habitat resistance output revealing suitable and non-suitable area. A Least cost path (LCP) approach was used to calculate the Cost Weighted Distances (CWD) between the identified cores. Also, central mapper tool was used to depict most important area of network amongst the core areas. The connectivity analysis generated six links between the targeted protected sloth bear habitats. The habitat resistance layer has shown maximum resistance in the areas with high anthropogenic disturbances. Balaram Ambaji has been identified in the present study as a significant zone connecting three sloth bear habitats one in north-west (i.e. (Jessore) and two in Central Gujarat (Ratanmahal and Jambughoda) each of which further can be elongated in south to Shoolpaneshwar wildlife sanctuary. The approaches discussed above can be beneficial once implemented on the ground level. However, it does require a longer-term study to obtain robust data to validate the effectiveness of predicted models. Though, such studies provide a substantial foundation for future research work dedicated towards alleviating human bear conflicts and promoting co-existence.