Executive Summary

of the Ph.D. Thesis entitled

Evaluation and Assessment of Habitat Connectivity for Sloth Bears between two Protected Areas in Central Gujarat

By Vaidehi Shah

FOS/2188

Under the Guidance of

Prof. Geeta Padate

Department of Environmental Studies
Faculty of Science
The Maharaja Sayajirao University of Baroda
Vadodara

Introduction:

Habitat degradation and fragmentation are the major threats to wildlife including sloth bears in Gujarat, India (Bhatt *et al*., 2015; Reddy *et al.,* 2017). Rapid urban and agricultural expansion have influenced the land cover of this habitat (Mahadevia, 1999). These changes have disturbed the habitat connectivity, posing threats for species with wide home ranges (Mullu, 2016).

Considering the afore mentioned, present study focuses on the evaluation and assessment of habitat connectivity for sloth bears in central Gujarat, across a proposed ecological corridor between Ratanmahal Wildlife Sanctuary (RWLS) and Jambughoda Wildlife Sanctuary (JWLS) (Malik *et al.,* 2023). The objectives of this study are;

1) A Study on Decadal Change in Land Use and Land Cover Pattern in the Sloth Bear Habitat.

2) Distribution of Large Mammals in the Corridor between Jambughoda WLS and Ratanmahal WLS.

3) To identify the driving and limiting factors for sloth bear movement in central Gujarat.

4) To Evaluation of the ecological corridors for sloth bears in the study area.

5) The Study of People's Perception and Conflict Scenario for Suggesting Sloth Bear Conservation Strategies.

Objective 1:

Land use and land cover change detection was carried out to note the loss in the forest cover (Chughtai *et al.,* 2021). Landsat-7 and 8 satellite images of winter were collected for 2012 and 2022. LULC classes were categorized into seven types- Water body, Agriculture, Barren land, Dense forest, Moderately dense forest, Open forest and Fallow land. A fragmentation analysis was carried out using Landscape fragmentation tool in ArcGIS v10.8 (Vogt *et al.,* 2007). The study area was divided into five regions- Jambughoda WLS, Pavi Jetpur range, Chhota Udepur range, Sagtala RF and Ratanmahal WLS. A region-wise comparison was also conducted. The LULC analysis revealed considerable loss of moderately dense and dense forests with conversion to agriculture and open forest. Dense forest area decreased radically, while open forest and barren land expanded. An increase in edges and a decrease in the core areas were observed suggesting habitat fragmentation. The region-wise LULC showed that the dense forest cover decreased in wildlife sanctuaries; while an increase was observed outside protected areas. Although disturbed, the habitat patches outside protected areas can act as connectivity for wildlife (Fialho *et al.,* 2019). The study indicates an implication of site-specific conservation strategy for the concerned area.

Objective 2:

The study to understand the spatial distribution of ecologically significant large mammals in the area carried out included Sloth bear, Leopard, Hyena, Blue bull, Four-horned antelope and Hanuman langur (Bellón *et al.,* 2022). Grid base field surveys were conducted in the forest patches to collect presence-absence data of these mammals in summer and winter. Relative frequency, abundance and density of the presence location of the six species were calculated (Garshelis *et al.,* 1999; Mahajan & Fatima, 2017). Following this, distribution hotspots were identified using Kernel Density Estimation (KDE) in ArcGIS (v10.8) which provided a visual interpretation of their distribution (Feiberg, 2007). Leopards were recorded across the entire study area in both seasons. Sloth bears were also widely distributed but showed seasonal variation, with sparse winter presence and no summer records in JWLS and Pavi Jetpur. Striped hyenas were restricted to forested regions of JWLS, Chhota Udepur range, and Sagtala RF in both the seasons. Hanuman langurs and Blue bulls occurred throughout the study area year-round, while four-horned antelopes had a patchy distribution limited to forested habitats. This study provides baseline information on the spatial ecology of key mammal species within a lesser-studied, fragmented landscape of central Gujarat.

Objective 3:

Earlier studies have noted that sloth bears have seasonal variations in their habitat use (Dharaiya & Rabari, 2022; Anand & Singh, 2025, Shah & Padate, 2025). Hence, a study to understand the factors influencing the species presence across the five regions was carried out in summer and winter. The variables were categorized into site variables (which do not show seasonal variation) - the LULC classes, and vegetation type and sample variables (showed seasonal variations) - water, prey and other preferred food. The data of variables were collected during grid-based field surveys in both the seasons. A paired T-test was conducted to check seasonal variation in resource availability and Euclidean distance matrix (EDM) was calculated to understand the closely associated variables and sloth bear presence (Chessel & Dufour, 2012; Frost, 2021). In addition, in-situ scat analysis (Baskaran & Desai, 2010) was carried out to check the species' food preference. Statistical analyses for resource availability identified that availability of termite/ants and water are the key drivers influencing sloth bear presence during winter. Whereas, the availability of fruiting trees and water are the factors influencing sloth bears in summer. Scat analysis showed that the bear's preference for ants and termites was higher in winter and that of

fruits was in summer. The study highlights that the seasonal variation in sloth bear presence aligned with the variations in resource availability.

Objective 4:

Seasonal sloth bear distribution pattern was studied using KDE; consecutively Relative Habitat Use (RHU) was calculated for two seasons summer and winter to determine the frequently used area among the five regions (O'Reilly *et al*., 2022). The LULC characteristics of each region was evaluated and compared with their use by sloth bears. Analysis on the regional variation in resource availability across the study area suggests that Chhota Udepur and RWLS provide sloth bear preferred resources year-round. However, Chhota Udepur had the highest RHU. It is also observed to prefer woody vegetation compared to mix and grassy habitats in both the seasons. Bears were found to use more open forest in winters and moderately dense forest in summers. This justifies the restricted use of area (Comita & Engelbrecht, 2009) during summers and the use of the habitat connecting the two wildlife sanctuaries in winters. Hence, it is concluded that the availability of open and moderately dense forests connecting forest patches is crucial for sloth bears in winter.

Objective 5:

Community based questionnaire surveys were conducted to understand the overlap in the use of forest as well as settlements by the sloth bears and the locals (Pillay *et al.,* 2022). The surveys provided additional insights into local perceptions and conflict dynamics (Patel *et al.,* 2025). The conflict information of 10 years (2012-2022) gathered from the forest department helped in identifying conflict prone areas. The Sagtala RF and RWLS was observed to have the highest sloth bear conflict cases, followed by Chhota Udepur and Pavi Jetpur; while JWLS had no recorded conflicts; coinciding with the sign surveys. Fear of sloth bears remained high in areas where conflict incidents were relatively low, influencing local tolerance levels. Sloth bear conservation measures for habitat connectivity with the help of local knowledge and the conflict cases were suggested.

Conclusion:

The study indicates that the corridor continues to hold ecological significance; however, its structural and functional integrity is increasingly threatened by habitat degradation and anthropogenic pressures. Changing LULC patterns in central Gujarat emphasize the need for site-specific habitat conservation interventions. Additionally, spatial variations in species distribution call for species-specific management strategies to reduce the impacts of habitat fragmentation.

Seasonal shifts in the sloth bear distribution, closely linked to resource availability, further highlight the importance of conservation planning to ensure year-round habitat suitability and resource availability. Overall, conservation efforts should prioritize habitat restoration, mitigation of human–bear conflict, and active community participation to secure the long-term sustainability of the corridor.

References:

Anand, A., & Singh, A. K. (2025). Vegetation as a Key Determinant in Sloth Bear Habitat Preference: A Systematic Review. *Asian Journal of Environment & Ecology*, *24*(7), 95-110.

Baskaran, N. and Desai, A.A. (2010). Does indigestible food remains in the scats of Sloth Bear *Melursus ursinus* (Carnivora: Ursidae) represent actual contribution of various diet items?

Bellón, B., Henry, D. A., Renaud, P. C., Roque, F. D. O., Santos, C. C., Melo, I., ... & de Vos, A. (2022). Landscape drivers of mammal habitat use and richness in a protected area and its surrounding agricultural lands. *Agriculture, Ecosystems & Environment*, *334*, 107989.

Bhatt, G. D., Kushwaha, S. P. S., Nandy, S., Bargali, K., Nagar, P. S., & Tadvi, D. M. (2015). Analysis of fragmentation and disturbance regimes in south Gujarat forests, India. *Tropical Ecology*, *56*(3), 275-288.

Chessel, D. and Dufour, A-B. (2012). Analysis of Ecological Data: Exploratory and Euclidean methods in Environmental sciences. RStudio Package-ade.14.

Chughtai, A.H., Habibullah, A. and Ismail, R.K. (2021). A review on change detection method and accuracy assessment for land use land cover. Remote Sensing Applications: Society and Environment, 22, 100482. https://doi.org/10.1016/j.rsase.2021.100482

Comita, L. S., & Engelbrecht, B. M. (2009). Seasonal and spatial variation in water availability drive habitat associations in a tropical forest. *Ecology*, *90*(10), 2755-2765.

Dharaiya, N., & Rabari, V. (2022). A systematic review on the feeding ecology of Sloth Bear Melursus ursinus Shaw, 1791 in its distribution range in the Indian subcontinent. *Journal of Threatened Taxa*, *14*(12), 22329-22336.

Fieberg, J. (2007). Utilization distribution estimation using weighted kernel density estimators. *The Journal of Wildlife Management*, *71*(5), 1669-1675.

Fialho, M. Y., Cerboncini, R. A., & Passamani, M. (2019). Linear forest patches and the conservation of small mammals in human-altered landscapes. *Mammalian Biology*, *96*(1), 87-92.

Frost, J. (2021). Paired T-test: Definition & When to Use It.

Garshelis, D. L., Joshi, A. R., & Smith, J. L. (1999). Estimating density and relative abundance of sloth bears. *Ursus*, 87-98.

Mahadevia, D. (1999). Economic growth and environmental degradation: case of Gujarat. *New Delhi: Research Foundation for Science, Technology and Ecology*, 1-165.

Malik, A., Singh, C.P., Dharaiya, N. & Padate, G. (2023). Potential connectivity for sloth bear habitats in Western India's landscape. European Journal of Wildlife Research 69(6), 118.https://doi.org/10.1007/s10344-023-01748-1

Mahajan M., and Fatima S. (2017). Frequency, abundance and density of plant species by list count quadrate method. *Epitome: International Journal of Multidisciplinary research*

Mullu, D. (2016). A review on the effect of habitat fragmentation on ecosystem. *Journal of Natural Sciences Research*, *6*(15), 1-15.

O'Reilly, E., Gregory, R. D., Aunins, A., Brotons, L., Chodkiewicz, T., Escandell, V., ... & Butler, S. J. (2022). An assessment of relative habitat use as a metric for species' habitat association and degree of specialization. *Ecological Indicators*, *135*, 108521.

Patel, V., Mesaria, S., Desai, P., Dharaiya, N., & Sasikumar, K. (2025). Perception and Attitude Toward Sloth Bear Melursus ursinus: Understanding the Tribal Communities from Central Gujarat, India, Coexistence with

Bears. *Human Ecology*, 1-7.

Pillay, R., Miller, D. A., Raghunath, R., Joshi, A. A., Mishra, C., Johnsingh, A. J. T., & Madhusudan, M. D. (2022). Using interview surveys and multispecies occupancy models to inform vertebrate conservation. *Conservation Biology*, *36*(2), e13832.

Reddy, C. S., Singh, S., Dadhwal, V. K., Jha, C. S., Rao, N. R., & Diwakar, P. G. (2017). Predictive modelling of the spatial pattern of past and future forest cover changes in India. Journal of Earth System Science, 126(1), 8.

Shah V., & Padate G., (2025). Factors influencing the seasonal presence of Sloth Bear *Melursus Ursinus* in Jambughoda Wildlife Sanctuary. *International Journal of Ecology and Environmental Sciences*, 51.

Vogt, P., Riitters, K. H., Estreguil, C., Kozak, J., Wade, T. G., & Wickham, J. D. (2007). Mapping spatial patterns with morphological image processing. *Landscape ecology*, *22*(2), 171-177.