SYNOPSIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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

Submitted by

Arzoo Malik

Under the Supervision of

Prof. Geeta Padate (Guide)

Dr. Nishith Dharaiya (Co-Guide)

DEPARTMENT OF ENVIRONMENTAL STUDIES,

FACULTY OF SCIENCE,

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA,

VADODARA, GUJARAT, INDIA. 390002

Chapter 1

1.1 Introduction

The bear family, Ursidae, is comprised of five genera and eight species. Bears are widely distributed across the Northern hemisphere in North America, Europe and Asia, and to a lesser extent in the Southern hemisphere in the south American continent. The family Ursidae falls under the order Carnivora, however, except for the polar bear, most bears are omnivorous, consuming plant matter, insects, fish, and mammals. They are usually large, sturdy, and powerful animals. All bears are plantigrade, i.e., they walk on their entire foot (McLellan et al. 1994). All extant bear species generally have some similar physical appearances. Bears are generally solitary and have a good sense of smell.

The sloth bear (*Melursus ursinus*) is endemic to Indian subcontinent. It is one of the four resident bear species of India and the only species found in Gujarat. the other three being Asiatic black bear, Himalayan brown bear (*Ursus arctos isabellinus*) and the Malayan sun bear. The Sloth bear is listed as a Schedule – I species under the Indian Wildlife (Protection) Act, 1972 and is listed as Vulnerable under the IUCN Red List of Threatened Species (Dharaiya et al. 2016).

Sloth bears are found in subtropical and tropical habitats. They are mainly nocturnal and generally inactive at mid-day resting in their dens which can be anything from naturally occurring caves, crevices between large boulders, the spaces between tree roots, and under fallen trees and shrubs (Eisenberg and Lockhart 1972, Laurie and Seidensticker 1977, Desai et al. 1997; Garshelis et al. 1999, Akhtar et al. 2007). Sloth bears are easily distinguished by their shaggy coat, which is usually black but can sometimes be blackish brown (Prater 1965; Brandder 1982). On the chest, there is a distinctive white or slightly cream-colored 'V' or 'U' shaped mark (Yoganand et al. 2006). Thin, short, greyish white hair cover the whitish long snout and back of head particularly neck and the ear regions. It is the only bear with long hair on its ears (Garshelis et al. 1999).

However, over the years their habitat has been reduced extensively due to habitat degradation. This has led to severe decline in their population (late 1800s to mid-1950s) ultimately resulting in their extirpation from some ranges in India (Garshelis et al.1999). Many studies have been conducted to find out the habitat and food ecology of this species (Baskaran et al. 1997;

Mewada and Dhariaya, 2010, Joshi et al. 1997). In recent years' focus has been shifted towards the declining trend of their population while increase in conflict situations with human.

Therefore, to address the increasing conflict situation, there is a need to develop techniques for habitat management and conservation for sloth bears. Accordingly, I have identified different measures to manage the habitat using Geospatial Techniques to reduce the human sloth bear interaction.

Objectives:

- o Identification of corridors between the sloth bear sanctuaries of Gujarat
- o Mapping of potential conflict zones in and around sloth bear habitats
- o Identification and development of natural water containment points inside the Jessore and Balaram Ambaji sanctuaries: A preliminary case study

Chapter 2.

2.1. Review of literature

Among the large carnivores found in India, sloth bears are quite unique in their inhabitations and adaptations. They are ubiquitously distributed in dry deciduous tropical forest patches across the country (Dharaiya et al. 2016; Sharp et al. 2020). Historically (mid-1800s), they were found in abundance, spread in the regions from Himalaya in north to Western Ghats of southern India (Gilbert 1897; Dunbar-Brander 1923; Phythian-Adams 1950; Krishnan 1972; Prater 1996). However, continuous poaching, habitat degradation and fragmentation has led to a sharp decline in their population leading to extinction of the species from some regions (Krishnan 1972; Garshelis et al. 1999b; Singh 2001). This has resulted in shrinking and fragmentation of their habitat and resulting in patchy distribution (Garshelis at al. 1999b; Johnsingh 2003; Yoganand et al. 2006; Sathyakumar et al. 2012). Presumably more than 40% decline in sloth bear population was observed due to unregulated extraction of forest resources, overgrazing, forest fires, tourism and developmental activities (Garshelis et al. 2008; Puri et al. 2015). Presently, they are known to inhabit lowland areas ranging up to 1000 meters (Garshelis et al. 1999a; Johnsingh 2003; Ratnayeke et al. 2007). The specialized morphological

characteristics such as shaggy coat, protrusible lower lip, missing pairs of incisors and long claws have enabled this species to survive in varied range of habitats (Domico et al. 1988: Garshelis et al. 1999b). Sloth bear movement is mainly driven by the presence of food resources in the area (Karanth et al. 2011; Kozakai et al. 2011; Barber-Meyer et al. 2013; Dupke et al. 2017; Pokharel et al. 2022). With this, continuous increase in conflict with human is being reported from several parts of the country (Sharp et al. 2020).

In Gujarat, sloth bear distribution is limited not only to protected habitats but also in the areas beyond the boundaries of protected habitats. These areas that are possibly inhabitable require conservation efforts for the survival of the species (Garshelis 1999b; Jhala et al. 2011; Sathyakumar et al. 2012; Dharaiya et al. 2016). Sloth bear population has been reported in protected as well as non-protected areas across the seven districts of the Gujarat state. The five protected areas cover 29602.1 sq. km i.e. 17.02% land of the state. Approximate number recorded in last census (2016) was 340 which shows an increase from 293 as per the previous census (2011) (https://forests.gujarat.gov.in/). The highest number of sloth bears have been recorded from Banaskantha region (North Gujarat, approx. 121) accounting for 57% of the total population found in the protected areas of the state.

This species residing in disconnected fragmented patches suffers a potential risk of low genetic variation, ultimately reducing possibilities of survival (Saunders et al. 1991; Harris et al. 1992; Dutta et al. 2015). Though large protected habitats are potentially an important source for maintaining sloth bear population, which can act as a source for adjacent habitats, maintaining the landscape connectivity allows the dispersal and movement of the species to poorly connected habitats (Yoganand et al. 2006). As only half of the total sloth bear population survives in protected areas, it is imperative to increase the connectivity between fragmented or degraded forest patches increasing the possibilities of gene exchange (Rodgers et al. 2002, Yoganand et al. 2006). Many studies have recognized ecological corridors as important tool for the conservation of bear population (Craighead 1980; Pelton 1985; Peek et al. 1987; Yerena 1989; Weaver et al. 1992; Akhtar et al. 2004; Yoganand et al. 2006; Ratnayeke et al. 2007, 2014; Dutta et al. 2016).

An Ecological corridor is the structural and functional connectivity between protected areas providing a passage between unconnected suitable habitats (Tischendorf and Fahrig 2000; Beier et al. 2008, Majka and Spencer 2008; Koen et al. 2014; Rudnick et al. 2012). It helps to estimate the resistance and facilitation for movement of wild animals (Tischendorf and Fahrig,

2000). It is a combined formation of targeted species and environmental variables affecting the landscapes (Merriam 1984). Different approaches that have been undertaken to identify connectivity between the landscapes are linkage mapping through least cost path (Adriaensen et al. 2003; Sawyer et al. 2011; Dutta et al. 2016), habitat resistance (Compton et al. 2007; McRae et al. 2013) and circuit theory (McRae et al. 2008; Buchholtz et al. 2020).

Agriculture and livestock farming, the major sources of livelihood in the eastern regions of the state, has led to constant deterioration of sloth bear habitat resulting in the rise of conflict cases (Dharaiya and Ratnayeke 2009). The two main reasons for increasing conflicts are the sharing of forest resources by both, or movement of both into each other's land (Dharaiya and Ratnayeke 2009). Sloth bear movements into human areas is driven mainly by two important components i.e., food and water. In dry deciduous forest, availability of food is not a problem however, in summer water is a limiting factor. This pushes bears outside their typical habitat towards available water sources in human habitation. Studies have revealed regular movement or sightings of sloth bears near water sources close to the villages after dark in summer (Sultana et al. 2015). Nevertheless, activities of sloth bears have been recorded within 500m of water sources irrespective of season (Bargali et al. 2012).

Chapter 3

3.1. Study Area

The present research work has been carried out in Gujarat state (western India) exhibiting various biological diversity and geomorphological features. The state, located between 20°07'N to 24°43'N latitude and 68°10'E to 74°29'E longitude, encompasses an area of 1,96,244 sq km (5.97% area of India), with 27 districts, 23 wildlife sanctuaries, 4 national parks and 2 biosphere reserves (www.forests.gujarat.gov.in). Present study focuses on the five protected habitats which are inhabited by sloth bears. These include Jessore, Balaram Ambaji, Ratanmahal, Jambughoda and Shoolpaneshwar wildlife sanctuaries (Figure 3.1). The study area covers a total of 12 districts covering five wildlife sanctuaries and 2 reserved forests namely Chhota Udepur and Polo forests. The Jessore and Balaram Ambaji wildlife sanctuaries in the north of Gujarat fall under the jurisdiction of Banaskantha district situated at the foothills of Aravalli range bordering the North East boundary of the state. The forest in north Gujarat, consisting mostly of a highly undulating terrain, falls under sub group 5A- Southern Tropical Dry Deciduous Forest and 6B- Northern Tropical Thorn Forest (Champion and Seth 1968).

These forests are dominated by the woody tree species like *Tectona grandis*, Bamboo, *Agle marmelosa, Acasia catechu, Butea monosperma, Anogeissus sp., Boswellia sp.,* etc. (Dharaiya 2008). Ratanmahal Sloth Bear Sanctuary in the central Gujarat is a hilly isle habitat for the sloth bears. It falls in the southernmost part of Dahod district (central Gujarat) and borders the state of Madhya Pradesh (Dharaiya et al. 2021). Geologically, it is located at the meeting of the Vindhya Range and Malwa plateau, which has dry teak forests at the foothills and mixed deciduous forests with dry bamboo brakes on the periphery (Trivedi 2003). The forest type is of dry deciduous scrub and southern tropical dry deciduous forest with high density of Mahua trees. Jambughoda sanctuary, also present in central Gujarat, comprises of hills and forests separated by the flat farmlands of the villages of the region. These hills are the extensions of southernmost hills of the Aravalli Range from north and Vindhya Range from the east. Forests of the Shoolpaneshwar Wildlife Sanctuary fall under South Gujarat region located on the North-eastern part of Narmada district, the terrain is mostly hilly (Gupta and Sharma 2020).
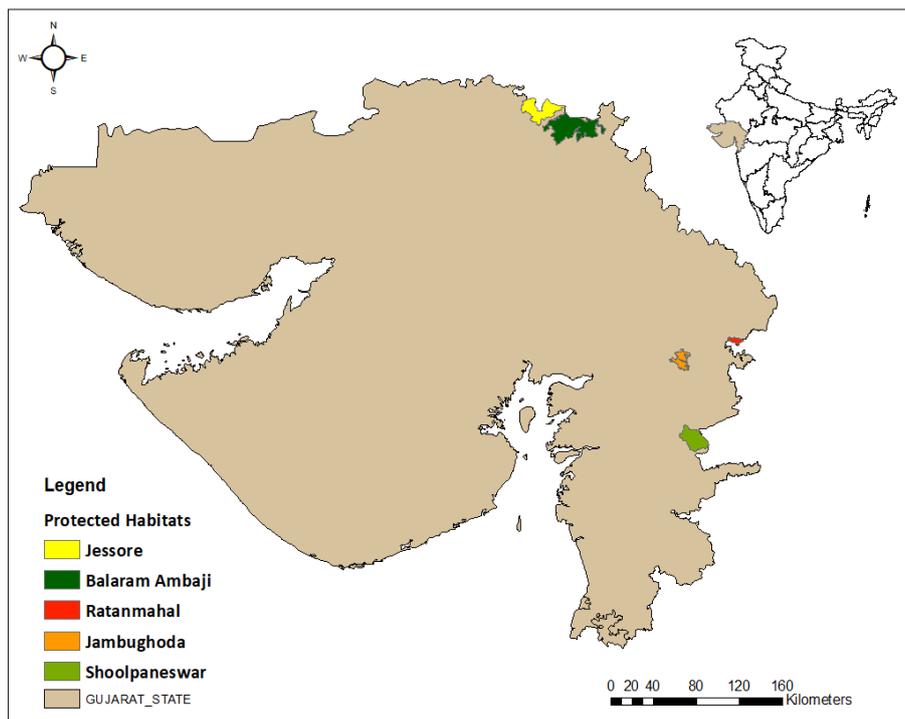

Fig 3.1. Study area representing sloth bear's protected habitats in Gujarat State.

Chapter 4

4.1 Objective1. Identification of corridors between sloth bear sanctuaries

4.1.1 Materials and Methods:

Data Sources: Resourcesat-1 LISS IV satellite imageries are procured from National Remote Sensing Centre (NRSC) for the study area and hybrid classification approach is used for land use / land cover (LU/LC) classification. Layers for Water bodies (rivers, natural and man-made wetlands) are taken from National Wetland Inventory data at 1:50K scale (Panigrahy et al. 2012; NWA 2011; Patel et al. 2015) while CartoDEM is used for generating slope. Further, Current India State of Forest Report maps are used to represent the forest density and reclassified into different classes. Major roads and railways dissecting the study areas are digitized using Google Earth Pro 7.1, and are further rasterized using ESRI ArcGIS$^{©}$ software.

Environmental Variables: Variabilities like forest cover (Mewada and Dharaiya 2010; Puri et al. 2015) sub categorised into four categories (Table 4.1) and LU/LC with sub categories such as wasteland, barren land, agriculture land, and scrubland (Can et al. 2014; Jain et al. 2021) are used. Additionally, the datasets on frequent sightings of sloth bears reported in surroundings of wetlands, ponds, dams, rivers are also used as suggested by Jain et al. (2022) and Paudel et al. (2022). Even though sloth bears are found in a varied habitat of different landscapes, we intend to check the effect of slopes in our resistance analysis based on previous literatures (Akhtar et al. 2004; Ratanyeke et al. 2007; Jain et al. 2021).

Table 4.1. Different layers used for the Resistance Layer

Data layer	Variables	Resistance Score
Forest cover	Non forest	4
	Open Forest	2
	Moderately Dense forest	4
	Very dense forest	5
Conflict zone	Very High	100

	High	100
	Medium	85
	Low	57
	Very low	28
LU/LC	Barren land	10
	Agriculture land	100
	Scrubland	42
	Wasteland	42
Road	Buffer 0.5km	45
	Buffer 1km	34
	Buffer 1.5km	22
	Buffer 2km	11
Rail	Buffer 1km	37
	Buffer 2km	24
	Buffer 3km	12
Settlement	Buffer 1km	67
	Buffer 2km	53
	Buffer 3km	40
	Buffer 4km	27
	Buffer 5km	13
Slope	Low	40
	Moderate	40
	High	13
Water bodies	Buffer 1km	49
	Buffer 2km	44
	Buffer 3km	39

	Buffer 4km	35
	Buffer 5km	30
	Buffer 6km	25
	Buffer 7km	20
	Buffer 8km	15
	Buffer 9km	10
	Buffer 10km	5

Anthropogenic variables: Through field survey, we gathered geo-tagged human bear conflict data and converted it into a spatio-temporal information. Transportation network and the data of human settlements are used as variables to represent the unsuitable habitat for sloth bear movements (Dutta et al. 2016; Jain et al. 2021).

Resistance model: For developing the habitat resistance layer, an integrated approach was adopted including analytical hierarchical process (AHP) and Gnarly toolbox in ArcGIS. With the help of AHP, weighted sum for individual variables were calculated, multiplied with the ranks assigned to each category of an individual layer leading to resistance score (Saaty 2004; Jain et al. 2021). The scale of the resistance score was kept between 0-100 where zero represents no resistance to maximum resistance given by a score of a 100 (Table 4.1). Gnarly utilities toolbox version 0.1.0 (updated 2015) was used to calculate the habitat resistance layer by summing up the resistance scores assigned to each variable (McRae et al. 2013).

Ecological connectivity: For building a network of connectivity between the protected areas, we took a least cost path (LCPs) approach. To demonstrate the quality of linkage paths, the ratio of cost-weighted distance to the length of the least-cost path **(CWD: LCP)** and ratio of cost-weighted distance to Euclidean distance **(CWD: EucD)** was considered. Further, to understand the importance of each protected area in developing the connectivity, we ran another tool known as Centrality Mapper on the mapped corridor (McRae 2012; Dutta et al. 2016).

4.2 Results:

The Forest cover in the study area accounts for 10330.96 sq. km, sub categorized into three types based on the density i.e., open forest (55%), moderately dense (40.5%), very dense

(3.68%). The geographical area covered under LU/LC is 91259.07 sq. km classified into agriculture land (79.4%), wasteland (16.1%), scrubland (4.5%) and barren land (0.002%) of the total area studied.

The resistance score reflects conflict zones with the highest weightage (23.02%) in contributing to the resistance for the connectivity, followed by LU/LC (19.52%) (Table 4.1). Evidently, most of the resistance was distributed around the conflict locations, settlements, and transportation network. The consistency ratio of AHP was 0.06 (<0.1) validating the resistance score for the variables used in resistance layer.

Six possible connectivity were identified in linkage analysis between the five protected areas (figure 4.1). There is a single linkage mapped between Jessore and Balaram in Northern region of the state with a lowest Euclidean distance (EucD- 2.14 km), least cost path (LCP-2.76 km) and cost weighted distance (CWD-532.81 km). Long Euclidean distance (231.06 km) was measured between Balaram Ambaji in North and Ratanmahal on the eastern edge of the state border. The least cost pathway and cost weighted distance estimated are 328.81 km and 19628.4 km, respectively. The ratio of CWD:EucD is minimum for the linkage formed between Balaram Ambaji-Ratanmahal (84.94 km), closely followed by linkage between Ratnmahal- Shoolpaneshwar (87.61 km) indicating low resistance in the movement of sloth bears through these areas. Similarly, the ratio of CWD: LCP was also low for these
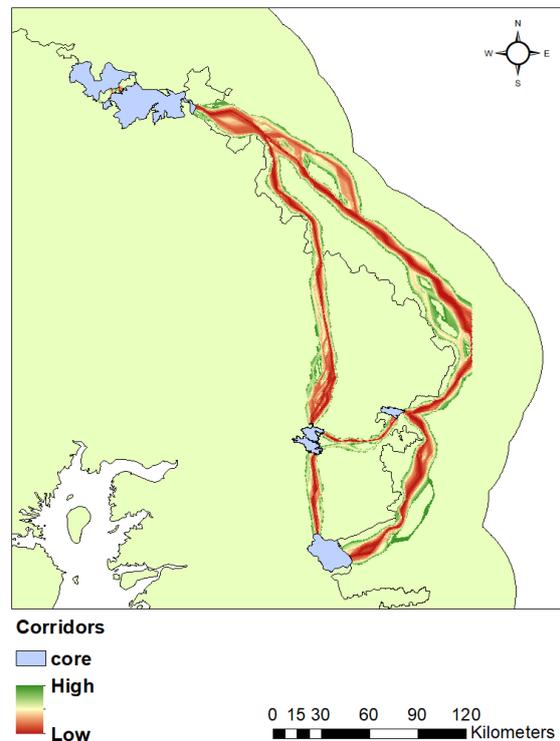

Fig 4.1. Least cost corridors identified between the core habitats of sloth bears. High resistance represented by green color, and red color is showing the lowest resistance for the corridors.

two linkages mapped between Balaram Ambaji-Ratanmahal and Ratanmahal-Shoolpnaeshwar (59.69 km and 59.75 km), identified as a suitable habitat allowing sloth bear's movement with minimum resistance. Even though, Balaram Ambaji and Jessore are geographically close, the cost of building a corridor is high (CWD:EucD, 249.32 km and CWD:LCP,193.04 km) due to the anthropogenic pressure caused by National Highway NH14 along with a railway track connecting to Rajasthan state by crossing the two sanctuaries. On the contrary, the centrality

flow (4 amps) was found to be maximum between Jessore-Balaram Ambaji. Almost similar centrality flow was estimated between Balaram Ambaji-Jambughoda, Ratanmahal-Shoolpaneshwar and Jambughoda-Shoolpaneshwar (CF:2.91 amps). The connectivity mapped in central and south region of the state between Ratanmahal-Jambughoda-Shoolpaneswar suggest an important network for conserving the sloth bear habitat.

Chapter 5

5.1 Objective 2. Mapping of potential conflict zones in and around sloth bear habitats

5.1.1 Materials and Methods:

Documenting species absence / presence: When detection probabilities of animals are less, often animal occurrence is recorded through easily detectable signs of presence (pugmarks, scat, claw marks etc.). These animal 'presence-only' signs are used as proxy to direct records (sighting, calls) and maybe used to determine site occupancy (Mackenzie et al. 2006). In present study the past recorded conflict locations were utilized to model the potential conflict areas.

Habitat suitability model: This model for Sloth Bear is built using eight predictor variables, subsumed under three broad categories: (i) resources—forest; (ii) regulators—water, slope, DEM; (iii) disturbance—distance to major roads, to settlements, to agriculture and to railways (Favilli et al. 2013).

Creating base land cover layers: LISS IV (Resourcesat-1) satellite images were procured for the study area and hybrid classification approach was used for land use / land cover classification as explained for objective 1 (Chapter 4). Four land-cover features –forest, water bodies, settlements and agriculture were extracted. Distance of each feature from any random point inside the area of study was computed using Euclidean distance which was used later for modeling.

Creating topographic (slope) and distance to roads layer: Slope of the landscape is extracted from ASTER Global Digital Elevation having a ground resolution of 30 meters. Major roads and railways dissecting the study areas are digitized in Google Earth Pro 7.1, and are further rasterized using Euclidean distance tool.

Modeling suitable habitat: We used Maxent version 3.4.0 (Phillips et al. 2017) to model habitat suitability. The output is generated in values ranging from 0 to 1. To simplify the model,

we used mostly default values, except a few tweaks. We opted to use 1000 iterations to improve its prediction accuracy. We kept the default 25 'random test percentage', which withheld random 25% of data for testing the model, and the rest is used to build or 'train' the model. Area Under the Curve (AUC) of the Receiver Operating Characteristics (ROC) is used to estimate how well each model predicts correctly (Phillips et al. 2017). The model is run using k-folding technique to optimize the use of all presence locations. The in-built cross-validation features 'splits' and 'folds', and the available presence-location geo-cache was used to retrain models, that resulted in an optimized averaged model (Phillips et al. 2006, Phillips and Dudik 2008). We also used jack-knifing technique, incorporated in the software, to estimate relative influence of each predictor variable in model training (Pearson et al. 2007).

5.2. Results:

In the developed model, forest is the most influential predictor, as measured by the gain when all variables are used. Relatively, digital elevation model contained most useful information by itself and influenced the gain positively. Second highest contribution is obtained for digital elevation model (DEM) (figure 5.1).

The average test AUC for the replicate runs is 0.907, and the standard deviation is 0.032 (figure 5.2). suggesting the good accuracy of the model.
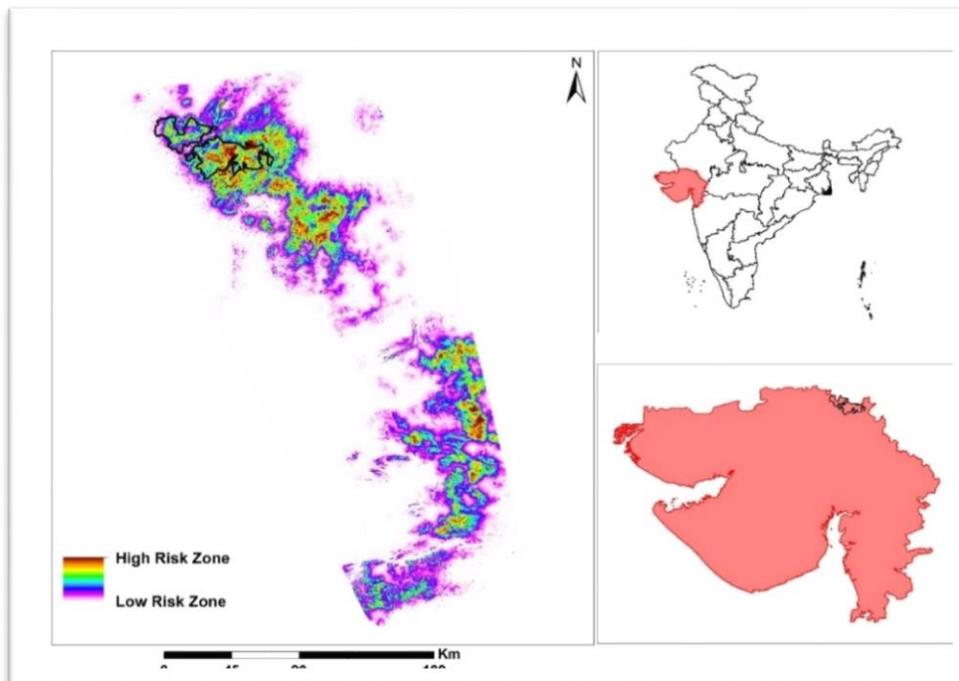

Figure 5.1: Map showing the potential conflict zone for human and sloth bear in Gujarat state.
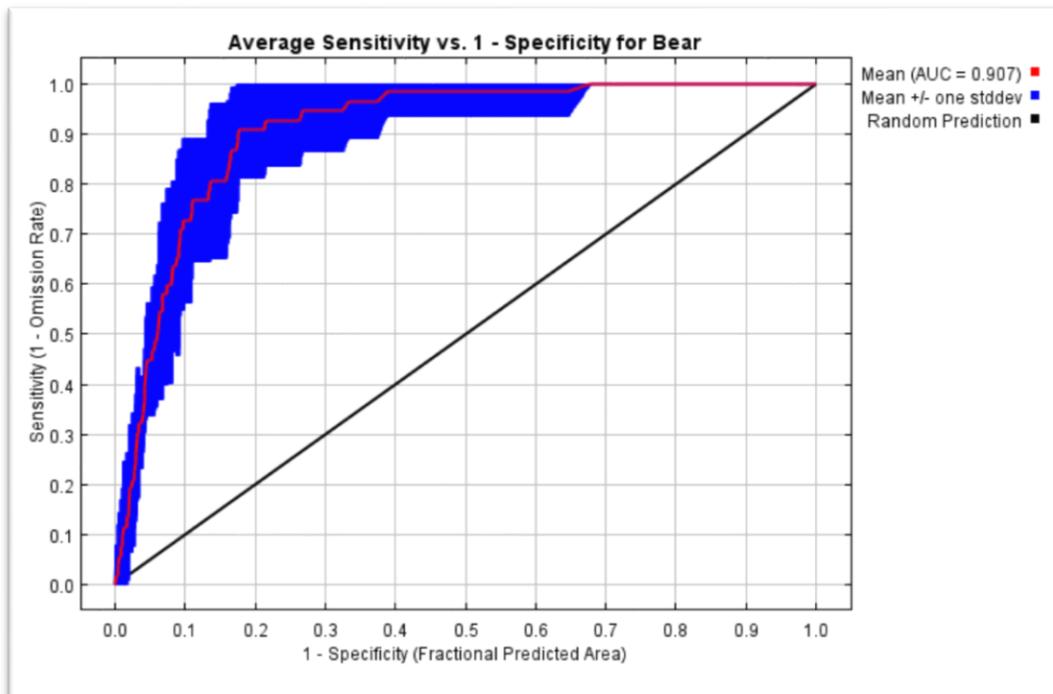
Figure 5.2: Graph showing average sensitivity test done for the replicates.

Chapter 6

6.1. Objective 3- Identification and development of natural water containment points inside Jessore and Balaram Ambaji sanctuaries: a preliminary case study

6.1.1 Materials and Methods:

Water sources were located by developing a drainage map of both sanctuaries (Figure 6.1a and 6.1 b) followed by hydrological modelling in ArcGIS ® 10.8 (Malik et al. 2018). Small streams converge to create potential areas where water can accumulate

In order to understand the dependence of sloth bears on available water, our surveys were divided into two time periods, before monsoon (March-April, 2019) and after monsoon (December 2019-January 2020). Line transects of 100m were carried out in three directions due to undulating terrain around water sources (Plumptre 2000; Fragoso et al. 2016) and Sloth bear signs such as scats, claw mark, and pug marks were recorded. Other factors potentially

affecting bear movement such as elevation, slope, habitat type (such as forest type, scrubland, rocky terrain), and distance from human settlements (Dutta et al. 2015; Mewada 2015) as described earlier were considered as covariates in this analysis too (Table 6.1).

Table 6.1. List of potential covariates affecting sloth bear movement in the study area

Covariates	Range/Categories
Elevation	200 – 700 (meters)
Slope	0 – 30 (Degree)
Proximity to settlements	1000 – 7000 (meters)
Food resources (Tree species)	*Eg. Zizyphus sp. Cassia fistula, Grewia flavesecnes, Diosyros melanoxylon*
Habitat type	Open forest, Moderately dense forest, Mixed forest, Rocky, *Prosopis sp.* dominated

Logistic regression within the R package was used to assess covariates for their influence on sloth bear movements outside of sanctuaries to access water (Wright 1995; Zhang 2016). To corroborate this analysis and because of small sample size of water sources machine learning was used to inform a Decision tree analysis and Random Forests to predict bear movement to water outside of sanctuaries (Valleta et al. 2017). The data collected from pre-monsoon and post-monsoon were merged for this analysis. Python Script was used based on environmental variables and proximity to settlements. Habitat type was categorized into five types: open forest, moderately dense forest, rocky terrain, Prosopis dominated forest, and mixed forest which were numbered 1-5 respectively. Additional data related to human-bear conflicts was obtained from the Deputy Conservator of Forests, Banaskantha Forest Division. Given the potential for water scarcity in the study area, it was assessed whether or not there was a relationship between the rainfall in any given year over a decade and sloth bear attacks, which usually happened in summer. Rainfall data was obtained from the Indian Meteorological Department (https://hydro.imd.gov.in/).

Results:

Twenty-six identified water accumulation points were within 1.5 and 7.0 km from the nearest village. All identified water sources were between 200m and 700m elevation. Variability in habitat composition was observed around all water sources differing from rocky terrain, Prosopis-dominated to moderately dense forests. Conflict records from the study area from the Banaskantha Forest Division revealed the occurrence of 26 attacks (41% of total) during summer, 19 attacks (30% of total) in winter and 16 attacks (25%) in the monsoon in the last decade (2010-2019).
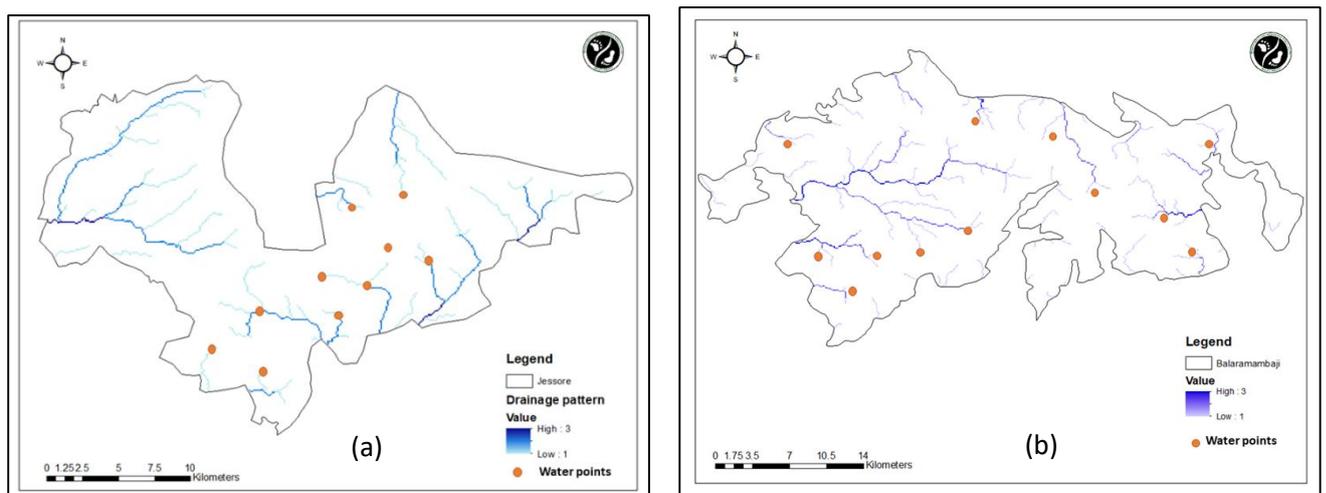

Figure 6.1. Drainage pattern of both sanctuaries by hydrological modelling and the orange dots illustrate the water points monitored for the present study [a] Jessore Wildlife Sanctuary [b] Balaram-Ambaji Wildlife Sanctuary

The presence of sloth bears was found within a100m perimeter at almost all water points during summer (76.9%). In contrast the pattern changed in winters, when sloth bear presence was recorded around 12 water points only out of twenty-six (46.2%). The data reveals that a total of 12 sites, seven in Jessore and five in Balaram Ambaji sanctuary, were regularly visited by sloth bears irrespective of season. Sites visited in Jessore were within 4 to 5km of human settlements and in habitats comprised of open to moderately dense forests. Whereas, the remaining five sites in Balaram region of the BAWLS were found to be within 1 to 4km of human habitation. Low rainfall was reported in the previous year (2018) of the study prompting bears to increase their search for water in summer. At the eight sites visited by bears before monsoon, no signs were recorded in winters. However, no significant influence on sloth bear presence was found when regressed with the selection of covariates that included typically attractive food resources and that bears often avoided proximity to villages (Table 6.2). The analysis revealed that none of the covariates tested have significant influences on sloth bear

movements to water in either season, indicating that sloth bears move around irrespective of these factors.

Table 6.2. Regression analysis of habitat variables with sloth bear presence before and after the monsoon in both the sanctuaries (SE= Standard error)
*α value=0.05

Variables	Before monsoon				After monsoon			
	Coefficient	SE	z value	p value	Coefficient	SE	z value	p value
Elevation	-6.487e-03	8.516e-03	-0.762	0.446	-3.826e-03	6.352e-03	-0.602	0.547
Slope	-1.044e-01	8.305e-02	-1.257	0.209	9.130e-02	6.495e-02	1.406	0.16
Proximity to settlements	-6.030e-01	5.614e-02	-1.074	0.283	-2.206e-01	3.644e-01	-0.605	0.545
Presence of food resources	-1.567e+01	3.838e+03	-0.004	0.997	-1.754e+01	2.584e+03	-0.007	0.995
Type of habitat	3.260e+00	1.989e+00	1.639	0.101	2.256e-01	1.070e+00	0.211	0.883

Concluding remarks

With the evident course of development and increasing anthropogenic pressure on forests, wildlife is at the verge of losing their present habitats. Continuous degradation of habitats results in consequences with respect to population decline and loss of genetic diversity. Thus, ecological connectivity is a significant attempt in allowing the gene flow between disconnected patches of habitats. The present study identifies the potential habitats with less density of sloth bears by connecting them with highly dense habitats through ecological corridors. Developing the ecological corridors once validated on ground level can lead to long term conservation of wildlife residing across the disconnected areas in the state. The study also discusses Mapping of potential conflict zones in and around sloth bear habitats and Identification and development of natural water containment points inside Jessore and Balaram Ambaji sanctuaries.

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Prof. Geeta Padate   Prof. P. Padmaja Sudhakar

(Guide)   (Head of the Department)

Department of Zoology   Department of Environmental Studies