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Evaluation of Suitable Habitat for Wild Boar (*Sus scrofa*) in Pench Tiger Reserve, Madhya Pradesh, India

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ABSTRACT

Habitat assessment is the primary task to ensure in-situ conservation of any species for its better management. We modeled habitat suitability of wild pig (*Sus scrofa*) in Pench Tiger Reserve (PTR) using Analytical Hierarchy Process (AHP) technique in GIS environment. Land Use Land Cover (LULC) map derived from Landsat 8 data along with other secondary inputs viz. topography and administrative coverage of the reserve were used as inputs in the model. Field experience and expert's comments are considered for assigning the final weightages to layers. The model revealed that a significant area of the reserve is suitable for the wild pig as they are generalist in nature. Our result revealed that wild pig prefers the areas which are close to the human habitat. This study also incorporates that remote sensing and GIS are a very important tool for wildlife habitat modeling with minimum efforts and low budget.

Key Words: Analytical Hierarchy Process; Central India landscape; Habitat Suitability; LULC

INTRODUCTION

Wild pig (*Sus scrofa)* authority) is commonly occurring species in many countries (India, Nepal, Bangladesh, Srilanka, Thailand, Indonesia, Pakistan) and is a known reservoir for many viruses, bacteria and parasites that are transmissible to domestic animals and humans (Meng et al. 2009). Due to alteration and encroachment of the habitat, have increased chances of contact, exposure of wild pig to humans and domestic animals. This creates an environment for the transmission of pathogens between wildpig and domestic pig and between wildpig and humans (Gibbs 1997). Apart from carrying the diseases wild pig plays an important role in environment, as it acts as scavenger and feeds on all dead animal and plant materials which make the forest floor clean. They also help in soil aeration and play an important role in seeds dispersal (Khan 2015, Khan and Ilyas 2018).

Wild pig is also an important prey species for the tiger and considerable proportion of wild pigis consumed by tiger in Pench Tiger Reserve (hereafter PTR) (Bhandari et al. 2017, Lamichhane and Jha 2015). PTR is known for its tiger Population. The large mammals such as tiger and leopard by virtue of their bigger size

and home ranges may face threats and if habitat degradation and prey depletion will continue for longer period they may face extinction (Schaller 1967, Prater 2005).Wild pigis one such mammal which contributes a major proportion in large carnivore diet.Despite of wild pig abundance and vast range of adaptability itcomes under least concern category as per IUCN. Belonging to the order Artiodactyla, it is found almost all across the country and its distribution spread across the Indian sub-continents.

The major threats for wild pig include bush meat hunting and man animal conflict because they raid agricultural fields nearby forested areas.This study is an effort to understand the ecology of wild pig and also attempt has been made to identify the spatial distribution and preferred habitats, using remote sensing and Geographic information system (RS and GIS) to reduce the man animal conflict in areas where suitable habitat lies near human habitation.Recent advancement in geospatial techniques has enabled the researchers to incorporate landscape level measures into ecological studies. Remotely sensed data provides capabilities for frequent, real-time assessment, monitoring and management of large areas (Kushwaha et al. 2004). The habitat suitability index (HSI) models developed for the number of species, has great importance in the management of wildlife and their habitats(Davis et al. 1990, Kushwaha and Roy 2002, Park and Lee 2003). The aim of habitat suitability model is to evaluate an area on the basis of the sustainability of important habitat factors for the given species. In other word it is to assess the detailed ecological information about the species and with the help of that characteristics of habitat can be evaluated (Kushwaha and Roy 2002, Kushwaha et al. 2000). As evident from the earlier review, a large number of studies have been carried out to evaluate the habitat of different species in various parts of the world as well as Indian subcontinent (Kushwaha et al. 2004, Park and Lee 2003, Hizrel et al. 2001, Roy et al. 2000, Imam et al. 2009, Ali 2014). This habitat evaluation at spatial and temporal basis will help the managersto manage the species and resolve the man animal conflict in PTR.

PTR represents tropical dry deciduous and tropical moist deciduous ecosystem in Central India. Earlier studies conducted in PTR were concentrated on the quantitative and qualitative description of vegetation structure (Sankar et al. 2001, Majumder 2011, Areendran et al. 2012). Basu 2012evaluated the impact of landscape changes on large mammal habitats in PTR, in which developed habitat suitability model for all large mammals including ungulates such as spotted deer, Sambar, wild pig and also for the carnivores such as tiger, leopard, and dhole. Many studies have been carried out in PTR earlier but the ecology of wild pig in relation to human-animal conflict is untouched yet. This study is an attempt to understand habitat type of PTR and the distribution of wild pig to identify the spatial distribution and preferred habitats near human habitation to avoid human animal conflict, using remote sensing and Geographic Information System.

STUDY AREA:

PTR (Madhya Pradesh) spreads across 757.89 km^2 area and is located in the Seoni andChhindwara District of southern Madhya Pradesh. This reserve comes under the SatpuraMaikal Landscape (78^0 55'' E - 79^0 35'' and 21^0 35'' - 22^0 00''N) (Figure 1).

The Central Indian Highlands have a tropical monsoonal continental climate, with a distinct monsoon (July to September), winter (November to February) and summer (April to June) andthe mean annual rainfall is around 140 cm, and the temperature varies from a minimum of 0°C in winter to 45°C in summer(Sankar et al. 2000).

Teak (*Tectona grandis*) and associated species such *as Madhuca indica, Diospyros melanoxylon, Terminalia tomentosa, Buchanania lanzan, Lagerstroemia parviflora, Ougeinia dalbergoides, Miliusa velutina* and *Lannea coromandelica,* occur on flat terrain. The undulating terrain and hill slopes have patches of Mixed Forest dominated by *Boswellia serrata* and *Anogeissus latifolia*. Species like *Sterculia urens* and *Gardenia latifolia* are found scattered on rocky slopes. Bamboo forests occur in the hill slopes and along streams. Some of the open patches of the Park are covered with tall grasses interspersed with *Butea monosperma* and *Zizyphus mauritiana*. Evergreen tree species like *Terminalia arjuna, Syzygium cumini* and *Ixora parviflora* are found in riparian vegetation along nullahs and river banks. *Cleistanthus collinus* dominant patches are also found in some parts of the Tiger Reserve.

The study area was classified into 12different classes using unsupervised classification such as bamboo, mixed, teak forest as well as human habitation and river bed. It includes eight forested areas and four non-forested areas such river and human habitation.

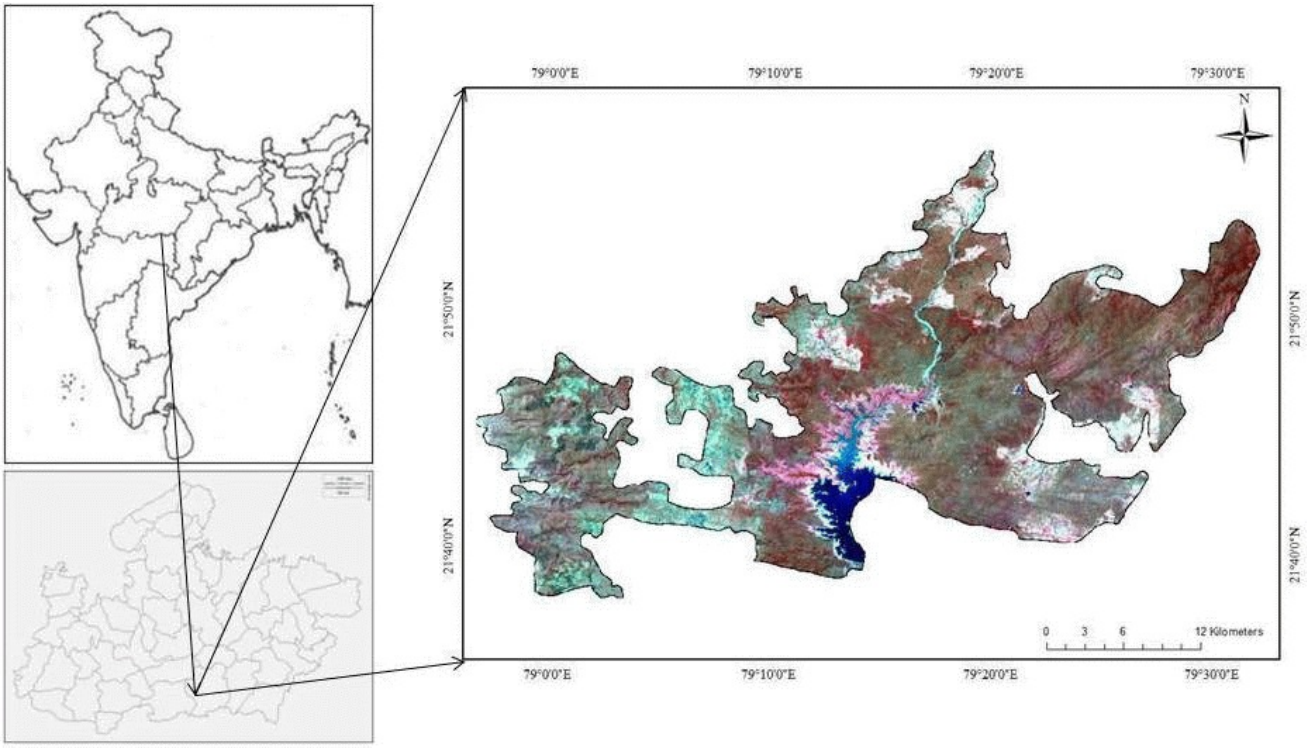

Figure 1.: Map of Study Area- Pench Tiger Reserve, Madhya Pradesh

MATERIALS AND METHODS:

The study was carried out in three phases. The first phase included collection and processing of satelliteand ancillary data (topographic maps and Digital boundary of Pench Tiger Reserve).Second phase included field survey and data collection of wild pig presence/ absence and ground truth verification for satellite data classification. The third phase (post-field work) included database creation and geospatial modeling

Data Collection and Data Processing

The satellite data of LANDSAT-8 (April 2015, 144-45 path and row) was acquired from the USGS website. It was further processed in ERDAS IMAGINE for geometric correction. From the satellite data a subset of area of interest was made using the forest boundary obtained from the authentic sources. The digital elevation model (DEM) data of Advanced Space-borne Thermal Emission and Reflection (ASTER) was also downloaded from the USGS website and then imported to ERDAS IMAGINE for preparing the layer maps of aspect and slope.

Field Survey

The field survey was carried out from Jan to April 2014. Pench Tiger Reserve is divided into three management ranges (Kurai range, Karmajhiri range and Gumtara range). Kurai range is also known as Pench Mowgli Sanctuary and Karmajhiri range and Gumtara range combine forms Pench National Park. It was not feasible to cover all the three ranges of PTR, So Karmajhiri range was selected as intensive study area for the collection of data. Overall 32 line transects of 2 km length were laid in different beats and on each transect further 10 circular plots were laid at every 200m interval. So overall 312 plots were laid and from which species presence/absence data were collected along with other variables such as tree cover, shrub cover, distance from nearest waterhole and nearest human habitation etc. Slope, aspect, elevation, and distances to roads were not recorded, as they are more accurately derived through satellite data post-processing in a GIS framework.

Post-field Analysis and Database Preparation for Habitat Suitability Analysis

The satellite data was digitally classified and the forest

vegetation map (habitat map) of the study area was prepared using unsupervised classification. The classification uses ISODATA algorithm for differentiating spectral reflectance of various objects. The accuracy assessment is the most important aspect to assess the reliability of maps and models derived from them, therefore Accuracy was tested using Cohen's Kappa Statistics (Lillesand and Kiefer 2000) using 100 randomly selected points.

Vector layers of roads and location of water body in the study area were generated using Google Earth and their Euclidean distance map was prepared for further analysis. All the layers viz. LULC, slope, aspect, distance from water body, distance from road and the slope mapswere ranked according to their ecological importance in context to the target species.

After ranking of the layers, a linear additive model used to evaluate suitable habitats. Weight assigned to different base layers, were evaluated by following Analytical Hierarchy Process (AHP) developed by Satty (Saaty 1980, Saaty 1991) that employspair-wise comparison matrix by using the relative scale measure. The weights of various variables were obtained from the above analysis and linear additive equation was calculated as follows:

HSI =

(2.22 x LULCI) + (1.16 x DFWI) + (- 0.42 x SI) + (-0.27 x DFRI)

where,
LULCI = Land use/Land cover Index
DFWI = Distance from waterbody Index
SI = Slope Index
DFRI = Distance from road Index

RESULTS

Land Use /Land Cover

The forested area dominated by mixed forest (26.87%) followed by teak mixed forest (23.68%), teak forest (16.3%), teak dominated forest (10.24%), Bamboo mixed forest (1.14%) and small patch of open area dominated with grassland comprises only 2.76%. The scrubland delineated from scrub land, lantana patch and area covered by *Argemone* species which comprises 3.88%, 0.34% and 1.13% of total area respectively. Human habitation including agricultural field contributed 9.69% of the area and waterbody along with the reservoir and dry river bed delineated 3.97% of total area (Figure 2).

Habitat Suitability Analysis

Following the linear additive model, the Habitat Suitability Index for wild pig in PTR was generated. On the basis of assigned suitability weightages, calculated output layers were reclassified. Reclassified raster layer shows areas as per their suitability categories for the wild pig.

Highly Suitable areas for the wild pig were calculated to be 240.69 km^2 and these areas are found as the adjacent areas of villages and water bodies. Suitable areas were calculated to be 212.96 km^2 and were found along with river and water channels. Moderately Suitable habitat areas were calculated as 126.77 km^2 and these areas were generally found at the tiger reserve boundary. Least Suitable habitat for wild pig which covers 212.39 km^2 and these areas were found in villages and open areas of Tiger Reserve (Figure 3).

DISCUSSION

The vegetation structure of any area plays very important role for forest and also for the distribution of animals as different animals prefer different habitats. Developing general understanding of vegetation and their patternsin different vegetation attributes at landscape level is of fundamental importance not only from the point of plant ecology but also from the perspective of gaining understanding of patterns in relationships between plants and animal communities (Ilyas 2001). Due to very fast depletion of forest cover in India, monitoring and conservation of forest cover is very important aspect and Remote Sensing and GIS contributed a major role in monitoring the changes in forest cover and ecosystem. The use of remote sensing data provides useful information about the trend of deforestation, habitat fragmentation, habitat alteration and change in any area (Joshi et al. 2009). Pench Tiger Reserve is the hottest region of Madhya Pradesh which comes under Biogeographic Province of Central Highlands (Rodgers and Panwar1988). According to Areendran2012the area was dominantly covered by teak forest and teak mixed forest somewhat similar to this study. In this study it was found that mixed forests (27% of total area) is most dominant forest of Pench Tiger Reserve. Earlier the area

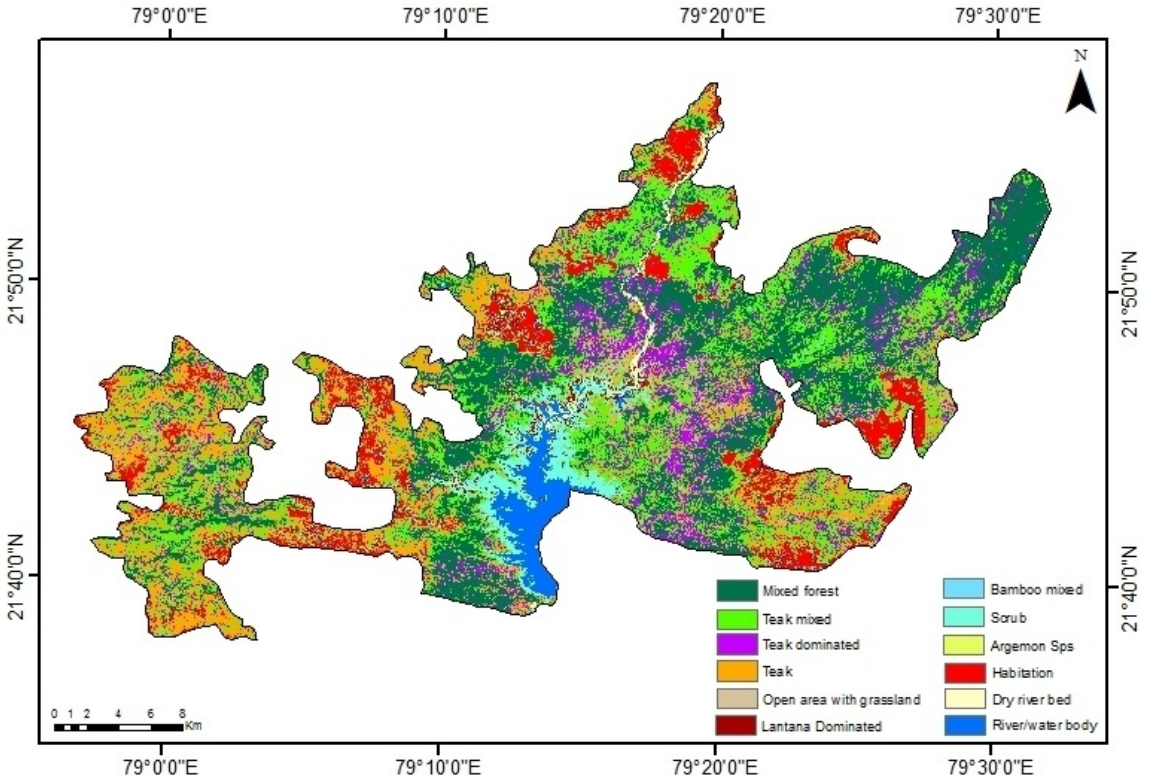

Figure 2. Land Use/Land Cover of Pench Tiger Reserve

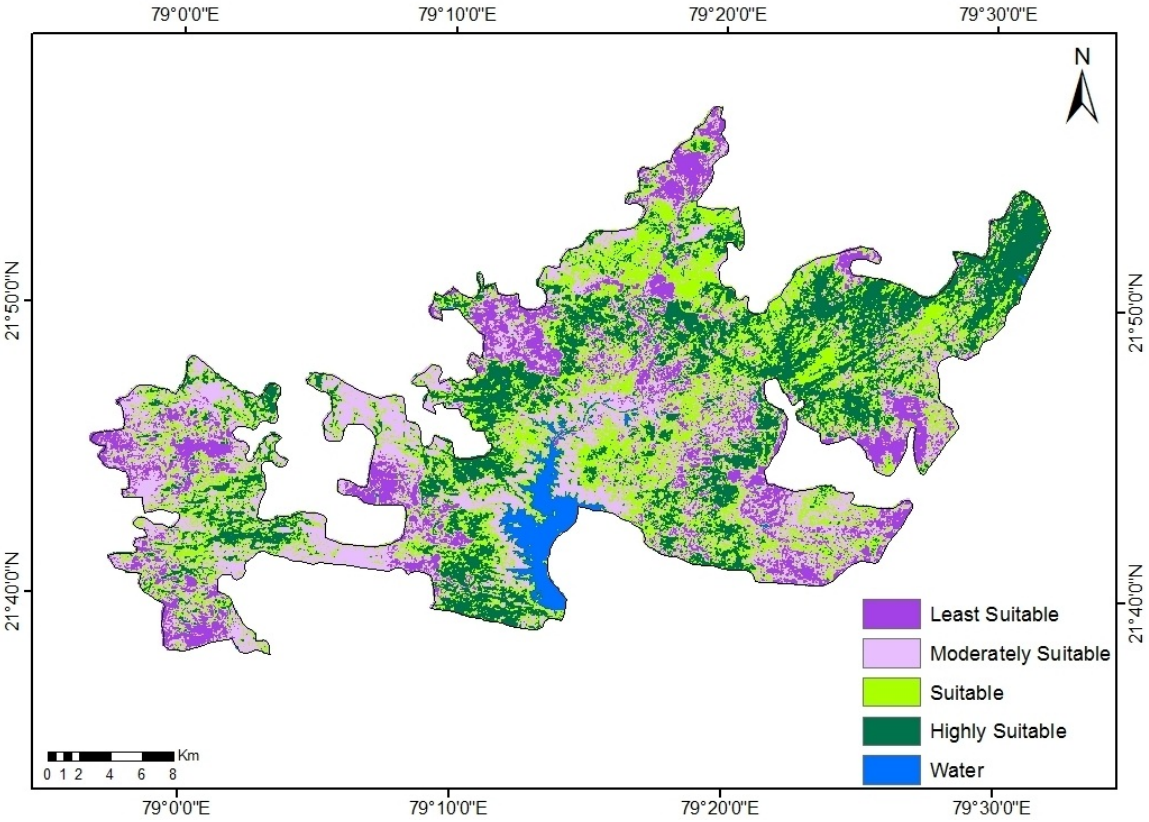

Figure 3. Habitat Suitability Map of wild pig in Pench Tiger Reserve

was covered by old teak plantation in recent past which is now converted in teak mixed forest and teak dominated forest(Basu 2012). The area of PTR is dominated by mixed forest and teak mixed forest of about 50.55% of total areawhich is almost similar of Basu 2012study.

The vegetation structure analysis of PTR landscape revealed its heterogeneous nature, as there was lot of variations found. Mixed forest contributed the maximum area cover of PTR (26.87%), which shows its dominance in terms of different land use/land cover classes and this is somewhat similar to Basu 2012 which showed that miscellaneous forest (38.9%) was most dominated forest of PTR. Second most dominant forest was found to be teak mixed forest which covers 23.68% of total area of PTR. Mixed and teak mixed forest are more dominant in sanctuary area may be because it is low disturbed area, as in sanctuary no tourism is allowed. Teak forest covers 16.30% of total area but found mostly outside the national park boundary near human habitation and very small patches of this kind of forest found inside the Pench National Park. Teak dominated forest covers 10.24% and mostly found near water body and moist areas. Some small patches of open area were also found inside the PTR boundary which seasonally dominated by grasslands and some bamboo dominated areas was also found. There are no villages in the Pench National Park area but some villages come under the boundary of PTR. Habitat use evaluation of a particular species is the first step towards the wildlife conservation and their management. Wild pig considered being very important game species in European countries as they are extensively studies species but in India it is somehow neglected. Wild pig plays important role in forest as they are considered to be important prey species of tiger and they are also opportunistic feeder as they feed almost everything (Baubet et al. 2004). For the evaluation of habitat use, extensive field work, large data base, statistical approach and modeling techniques will be helpful in predicting the suitable habitat for wild animals.

In this study the habitat suitability of wild pig was evaluated in PTR and result shows that 240.69 sq. km (30.36%) area of the PTR foundhighly suitable whereas 212.69 sq km (26.86%) suitable, 126.77 sq km (15.99%) found moderately suitable and 212.39 sq km (26.79%) are least suitable habitat. Most of the sanctuary area of PTR and also the adjacent area of villages was found to be most suitable. This may be attributed to the scavenger habit of the Wild Pig and hence they prefer these areas. Generally, the areas which are near to water body are found suitable and dry river bed and open areas are found moderately suitable may be the reason that they are shy animals and generally not prefer open areas. As perceived from result, the areas with high human habitation and disturbance were found least suitable.

We analyze the result with zonal statistics to compare the Habitat suitability results with field observations and found that our results are reliable. Mixed forest are the most suitable habitat for wild pig may be because it provides shelter as it is dense and provide variety of foods to them(Kearney and Gilbert 1976). Teak mixed forests are suitable habitat for them and teak forests are the moderately suitable may be because under growth are low teak forests and they feed on seedling and saplings of the trees which is less available in pure teak forests (Have and Bratton 1976; Wood and Barrett 1979, Genov 1981, Hove et al. 1981, Singer et al. 1981, Hone 2002). Human habitation, teak and teak dominated forest are the least suitable habitat for wild pig (Table 1).The study suggest that the most suitable habitat for the wild pigs are the Mixed and most of the area of most suitable habitat is near to the human habitation. Being close to the human habitat the wild pig may get mixed up with the domesticated pig, and cattle. The interaction of wild pig may allow transmission of the disease from wild to domesticated pigs and cattle, which causes man animal conflict.

Table 1. Zonal statistics analysis of Land Use/ Land Cover map (areas in km^2) and HSI map

Habitat/Class	River/ Waterbody	Mixed Forest	Bamboo Mixed	Teak Mixed	Open area with Grassland	Argemone sp.	Lantana dominated	Scrub	Teak Dominated	Teak	Habitation	Dry River Bed
Least Suitable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	70.22	84.21	53.02	4.81
Moderately Suitable	0.00	0.00	0.00	0.00	0.00	2.21	6.66	29.49	14.21	49.01	25.07	0.12
Suitable	0.00	0.00	7.56	177.81	22.01	0.64	2.57	2.37	0.00	0.00	0.00	0.00
Highly Suitable	0.00	221.32	1.78	16.87	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00

To avoid the transmission of diseases and the conflict there are some suggestions for alternative strategy to avoid the conflict, and the best alternative is to shift the nearby villages which is overlapping with the suitable habitat of Wild pigs. Since this is a time taking and expensive process and can raise various anthropogenic issues, meanwhile the domestic animals like cattle and pig should be monitored regularly for their health checkup. They should be vaccinated on time to time and stall feeding should be encouraged. Inside the Pench the wild pig population is increasing and it is the need of time to control the population and efforts can be made to develop the suitable habitat far from the human habitation highly suitable habitat to avoid the conflict.

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