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# Habitat Suitability Analysis for Sambar (Rusa unicolor) using Remote Sensing & GIS in Bandhavgarh National Park, M.P., India.

**[1]Abhishek Mishra, [2] Priyanka Dwivedi[*], [3]Jyoti Sarup**

[1]Department of Earth Science, Barkatullah University, Bhopal, India
[2] M.P. Council of Science & Technology, Bhopal, India
[3]Department of Civil Engineering, Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh, India
[*]Corresponding Author email: dwivedi.priyanka1490@gmail.com

***Abstract:*** The concept of wildlife species conservation starts with the identification of their suitable habitat as it provides essential information for wildlife refuge design and management. In the present study, evaluation of Sambar (Rusa unicolor) habitat was carried out in Bandhavgarh National Park (BNP) lies between 23⁰ 27' 00" to 23⁰ 59' 50" North latitude and 80⁰ 43' 15" to 81⁰ 15' 45" East longitude. Satellite imageries of sentinel-2A the study area was digitally processed by using remote sensing, ground data and other ancillary data, these datasets were integrated with GIS environment using multi-criteria analysis (MCA) model. For the modeling, several variables in the dataset viz., forest cover density, slope, aspect, altitude, road, water body, settlement and drainage were used as independent variables in the analysis. All these data sets were considered as input data for developing the model. Expert views and field experience were considered while allotting values to variables for MCA to generate final weight. The habitat parameters have dreadful impact over the habitat utilization and suitability pattern of Sambar in BNP. From this study most suitable habitat for Sambar in BNP is 1257.68 km² which is 56.20% of the total geographical area of the national park while 509.80 km² area comes under moderately suitable for Sambar which is 22.78 % of the total geographical area of the national park. The results pointed out that 78.98 % of BNP has been found to be high to moderately suitable for Chital habitat. The results have been found to be an important input as baseline information for population modeling and natural resource management in the national park.

***IndexTerms*** **- Habitat Suitability, Remote Sensing, GIS, Sentinal-2A, MCA**

## I. INTRODUCTION

India is remarkable for the variety of its large mammals, richness in species exceeded by few countries in the world (George Schaller, 1967). Schaller goes on to conclude in the introduction to his landmark work. The Deer and the Tiger, "In India perhaps more than in most countries, the basic problem of animal and human ecology is intimately related, and a solid body of facts is desperately needed if conservation and management practices satisfactory to man, his livestock, and the wildlife are to be initiated in time to save the last from complete extermination."

Effective conservation of wild species populations requires an understanding of the relationship between populations and their habitats. Scientists have developed multivariate explicit models for conservation ecology, covering many aspects of population viability analysis, biogeography, conservation biology, climate change research, biodiversity loss risk assessment, landscape management for endangered species, ecosystem restoration and habitat or species management. Habitat Suitability Models (HSM) of plants and animals has also come into vague consideration for biodiversity conservation.

To build Habitat Suitability Models (HSM), the comprehensive knowledge of potential factors affecting habitat choice of species coupled with their geographical distribution is critical to produce meaningful mapping outputs. As a tool for wildlife managers, the application of HSM becomes more essential day by day not only for effective recovery of wildlife but for predicting potential areas of high habitat quality for a given species to be conserved.

Chital also known as spotted deer, the most common of all deer found in the subcontinent, it is easily identifiable by its beautiful golden brown coat that is decorated with big white spots. An average stag is about 85-90 cm tall at its shoulder and weighs 80 kg. Unlike other ungulates, the coat of the spotted deer remains more or less the same throughout the year. Large herds can be seen in almost all the National Parks of North India.

Thus, the main objective of this study was to explain the usefulness of remote sensing and GIS technique along with ancillary information, to develop the best habitat suitability model for chital.

## II. STUDY AREA

The Bandhavgarh National Park is located in the eastern part of Madhya Pradesh at the central part of India. It dwells around the Umaria-Shahdol district surrounded by the Satpura mountain range. The latitude and longitude are lies between $23^0$ 27' 00" to $23^0$ 59' 50" North latitude and $80^0$ 43' 15" to $81^0$ 15' 45" East longitude, falls under the survey of India toposheet 64E/1, 64E/2, 64E/3, 64A/13 and 64A/14. The park is elevated at an altitude between 410 m and 810 m. The buffer zone has three administrative zones - Manpur, Dhamokhar, and Panpatha.

The mountains of Bandhavgarh tala range are being composed of sandstone and the soil is sandy to sandy loam. The whole park is filled with more than 20 luminous streams out of which some of the most important streams are Johilla, janadh, charanganga, Damnar, Banbei, Ambanala and Andhiyari Jhiria. These streams then merge into the son river, an important southern tributary to the river Ganges. Along with that many caves and lakes can also be found at the vicinity of Bandhavgarh National Park specially around the area of the fort which is the most majestic and ancient part of Bandhavgarh.

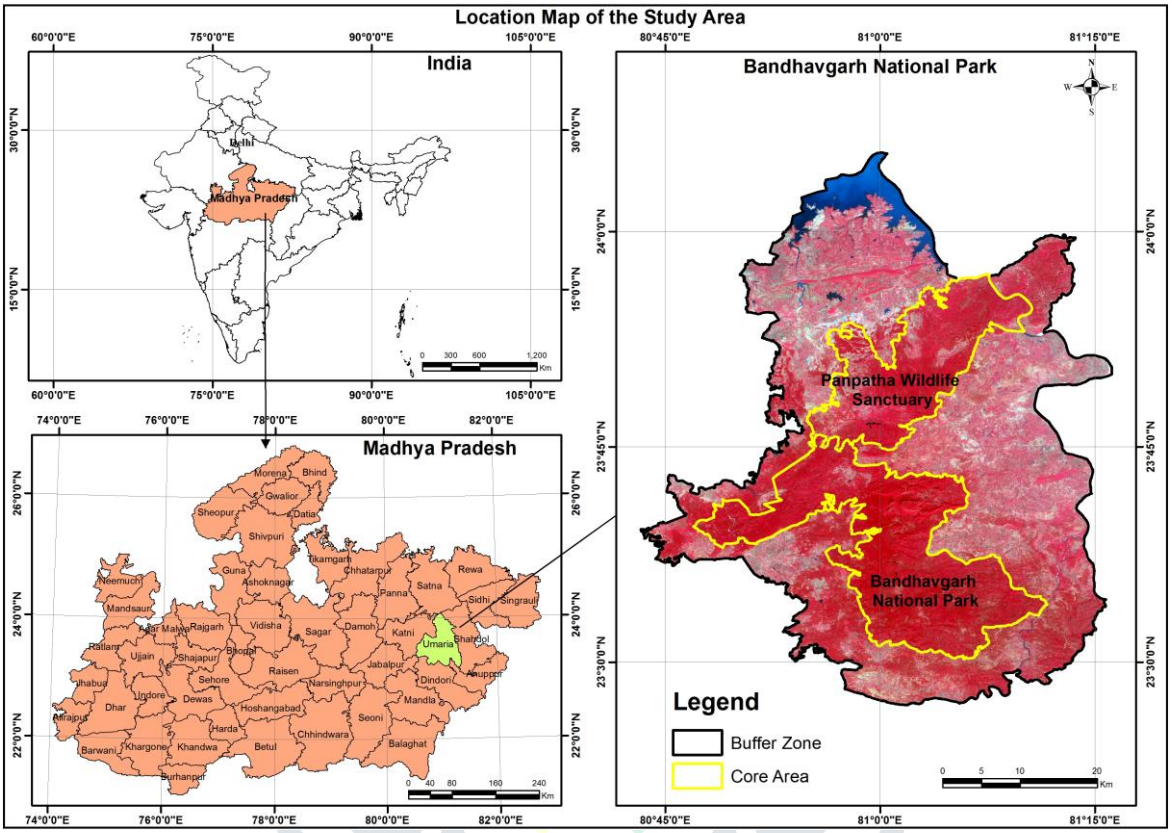


Figure 1: Location Map of Bandhavgarh National Park

## III. RESEARCH METHODOLOGY

The research in Habitat Site Suitability has been undertaken by well-programmed and integrated approach set up on reliable methodology for data collection, carrying out field survey, identification, selection and evaluation of GPS data. It has been completed in five phases:

### 3.1 Integration of Remote Sensing and GIS

The research in Habitat Site Suitability has been undertaken by well-programmed and integrated approach set up on reliable methodology for data collection, carrying out field survey, identification, selection and evaluation of GPS data. It has been completed in five phases:

- Data Collection.
- Digital Image Processing
- Remote sensing data Integration with GIS.
- Suitability Mapping in GIS Environment.
- GIS Analysis.

### 3.2 Buffer Analysis of Linear Features

Buffer analysis was used for identifying areas surrounding geographical as well as manmade features. The process involves generating a buffer around existing geographic and manmade features and then identifying or selecting features based on whether they fall inside or outside the boundary of the buffer. In case of geographical information systems, the units of buffering are points, lines, and polygons. Buffer operation refers the creation of a zone of a specified width around a point, a line or a polygon area. In this study involve the line as well as polygon buffering process for river & water body, transportation system and human settlement.

### 3.3 Rasterization

The Rasterization is process of the conversion of points, lines, and polygons into cell data. In other words, the term rasterization can in general be applied to any process by which vector information can be converted into a raster format. Rasterization process required in this study for weighted overlay function using ArcGIS 10.5.

### 3.4 Reclassification

Reclassification means process of taking input cell values and replacing them with new output cell values. Reclassification is often used to simplify or change the interpretation of raster data by changing a single value to a new value or grouping ranges of values into single values-for example, assigning a value of 1 to cells that have values of 1 to 50, 2 to cells that range from 51 to 100, and so on.

### 3.5 Integration Analyses in GIS Environment

A habitat suitability map has been constructed using Arc GIS, using the software all maps have been rasterized, reclassified and given appropriate weight to enable their integration for multi criteria evaluation (MCE). Suitability maps have been developed by integrating expert opinion with Geographic Information System (GIS) database. The 0-9 points scale multicriteria evaluation methodology has been implemented to solicit the importance of ground characteristics for Chital habitat from field experts. The layers of interest have been forest density, vegetation type, land use, lithology, slope, topography and some other human disturbance factors. The evaluations of the respondents showed a high level of agreement.

Table:1 Influences and weightage of different thematic layers for contributing habitat for Chital in Bandhavgarh National Park.

| Raster Layer | Influence % (Theme Weight) | Feature Classes or Buffer Distance | Feature Class Weight |
|---|---|---|---|
| Forest Cover | 30 | **Forest density** | |
| | | Dense Forest | 5 |
| | | Low dense Forest | 7 |
| | | Open/Scrub Forest | 9 |
| | | No Forest | 3 |
| River & WB | 25 | **River & WB Buffer** | |
| | | 0-500 m | 9 |
| | | 500-1000 m | 7 |
| | | 1000-2000 m | 5 |
| | | 2000-3000 m | 3 |
| | | Above 3000 m | 1 |
| Slope | 15 | **Slope Gradient in Degree** | |
| | | 0-3 % | 2 |
| | | 3-5 % | 9 |
| | | 5-10 % | 7 |
| | | 10-15 % | 5 |
| | | 15-35 % | 3 |
| | | Above 35 % | 1 |
| Topography | 10 | **Elevation in meter** | |
| | | 233-400 m | 9 |
| | | 400-500 m | 7 |
| | | 500-600 m | 5 |
| | | 600-700 m | 3 |
| | | Above 700 m | 1 |
| Drainage density | 10 | **Drainage Density** | |
| | | Very high | 9 |
| | | High | 7 |
| | | Moderate | 5 |
| | | Low | 3 |
| Road & Rail | 5 | **Distance to Road & Rail** | |
| | | 0-100 m | 4 |
| | | 100-500 m | 3 |
| | | 500-1000 m | 5 |
| | | 1000-2000 m | 7 |
| | | Above 2000m | 9 |
| Human Settlement | 5 | **Distance to Settlement** | |
| | | 0-100 m | 2 |
| | | 100-500 m | 4 |
| | | 500-1000 m | 6 |
| | | 1000-2000 m | 9 |
| | | Above 2000 m | 9 |

### 3.6 Multi-criteria Analysis

A model to evaluate Chital suitability has been developed using multi criteria suitability index approach by integrating different inputs parameters. Each parameter has in the form of output map derived from source layers and have been categorized in 0-9 scale which was further grouped into highly suitable 8-9, high suitable 6-8, moderately suitable 4-6, less suitable 2-4 and unsuitable 1. Further weights were assigned to each parameter to reflect their relative significance. The weightage for each parameter was determined by considering its importance in defining Chital habitat suitability as well as its ecological value, derived from literature review and expert knowledge.

For Chital Habitat Suitability analysis forest density has assigned the weightage of 30, distance to water (25), slope (15), topography (10), drainage density (10), distance to road & railway (5) and distance to habitation have been assigned the weightage of (5). Finally, all the parameters (P1…P9) have been integrated to derive the chital habitat suitability map. As this approach was common in a management decision or policy making context, the critical concern was whether the map was so sensitive to variation in inputs that a different decision would be reached with a different realization of the inputs. A simple correlation between range-wise estimated suitable area and their respective chital population distribution has used to qualitatively assess the model prediction.

## IV. Results and Discussion:

The delineation of habitat suitability zone by reclassifying into different potential zones highly, high, moderate, low and unsuitable (Figure: 3) was made by utilizing the criteria for GIS analysis have been defined on the basis of field survey, field data and experts knowledge, appropriate weightage has been assigned to each layer according to relative contribution towards the desired output. The map produced has shown that the habitat suitability zone of the study area was related mainly to forest density, forest type, availability of water, slope and topography of the area.

The integrated resulted have been shown in a Composite Habitat Suitability Unit map (CHSU). The output CHSU map is a surface with all the pixels having unified weight values named as Composite Habitat Suitability Indices (CHSI). These CHSI range from 2 to 9 Figure: 2 (h) higher the value indicates more suitability and lower value indicates lesser suitability. The Habitat Suitability potential zones map generated through this model was verified with the field data to ascertain the validity of the model developed. The verification showed that the habitat suitability zones demarcated through the model are truthful.

The habitat evaluation for the wild animals depends on the various environmental and ecological factors like vegetation type, height, slope, drainage patterns, water proximity, habitation, roads & railways construction, forest type and prey availability. In the Present study we analysis the habitat suitability and preparation of the habitat suitability map for the chital based on weighted rank given by opinion of expert, topographic map, remotely sensed data through and field survey method were applied. For the present study area weightage maps Figure: 2 (a to g) of the parameters forest density, slope, distance to water, topography, drainage density, distance to habitation and distance to road and railway have been assigned respective theme weight and their class weights.

The Final Habitat Suitability map generate from weighted overlay analysis show that out of total geographic area of 2238 $km^2$, highly suitable area is 8.41% (188.14 $km^2$), and high suitable area 27.65% (618.77 $km^2$) while moderately suitable class cover 33.29% (745.14 $km^2$) and less to not suitable class covers about 30.65% (685.92 $km^2$) area. It is clearly indicating that about 69% Area of National Park are suitable for Chital habitat and only 31% area are not favorable.

**For Chital:**

HSM = (FDwt * 0.30) + (DWwt * 0.25) + (Slopewt* 0.15) + (Elvwt * 0.10) + (DDwt * 0.10) + (DHwt * 0.5) + (DR&Rwt * 0.5)

Here,

SM = Habitat Suitability Map, FD = Forest Density, DW= Distance to Water, ELV= Elevation, DD = Drainage Density, DH = Distance to Habitation, DR & DR = Distance to Road & Railway, wt = Feature class weight.

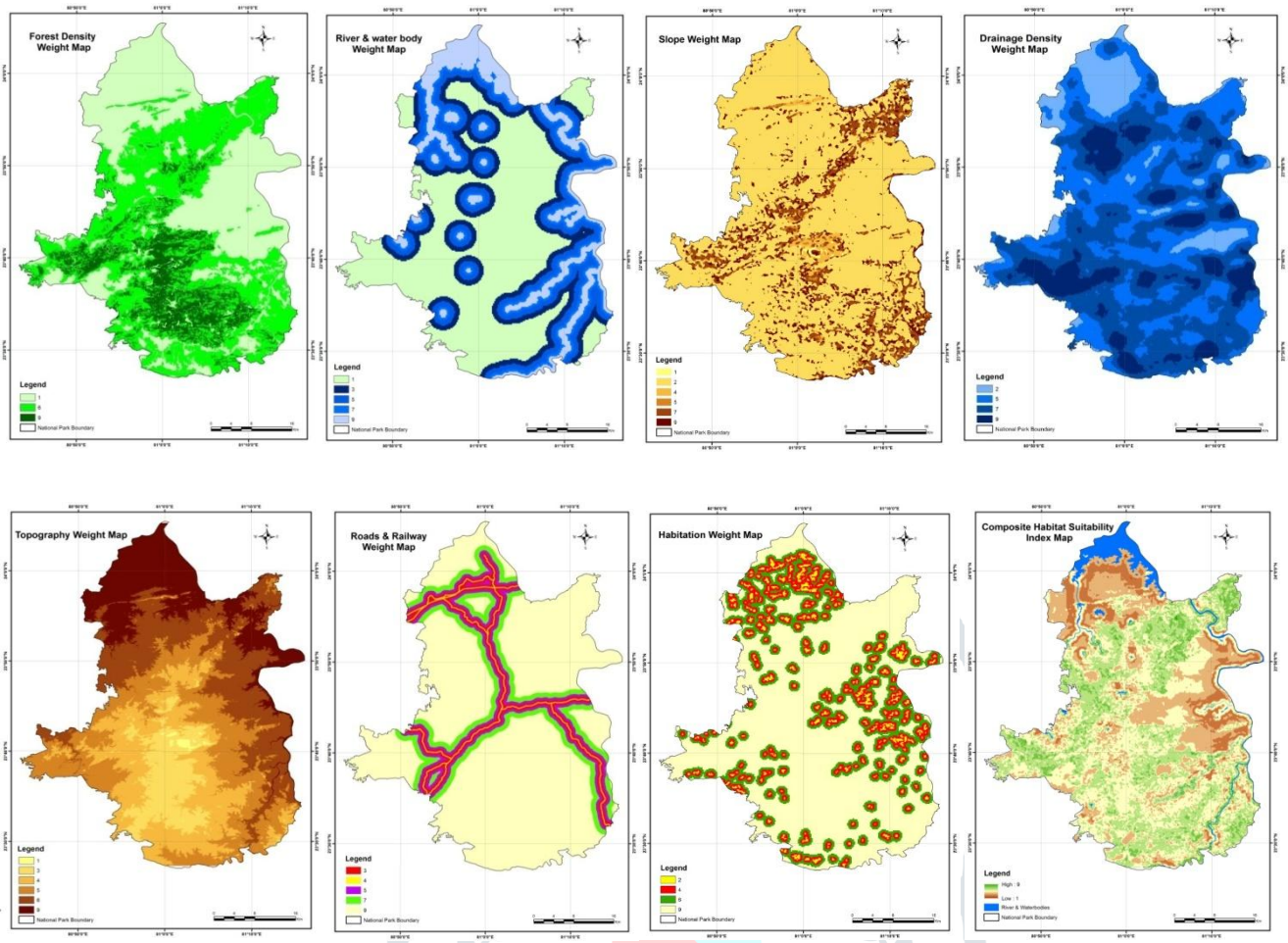


Figure 2: Weight Maps (a) Forest density, (b) River & Water body, (c) Slope, (d) Drainage density, (e) Topography, (f) Roads & Railway, (g) Habitation, (h) Composite habitat suitability map.

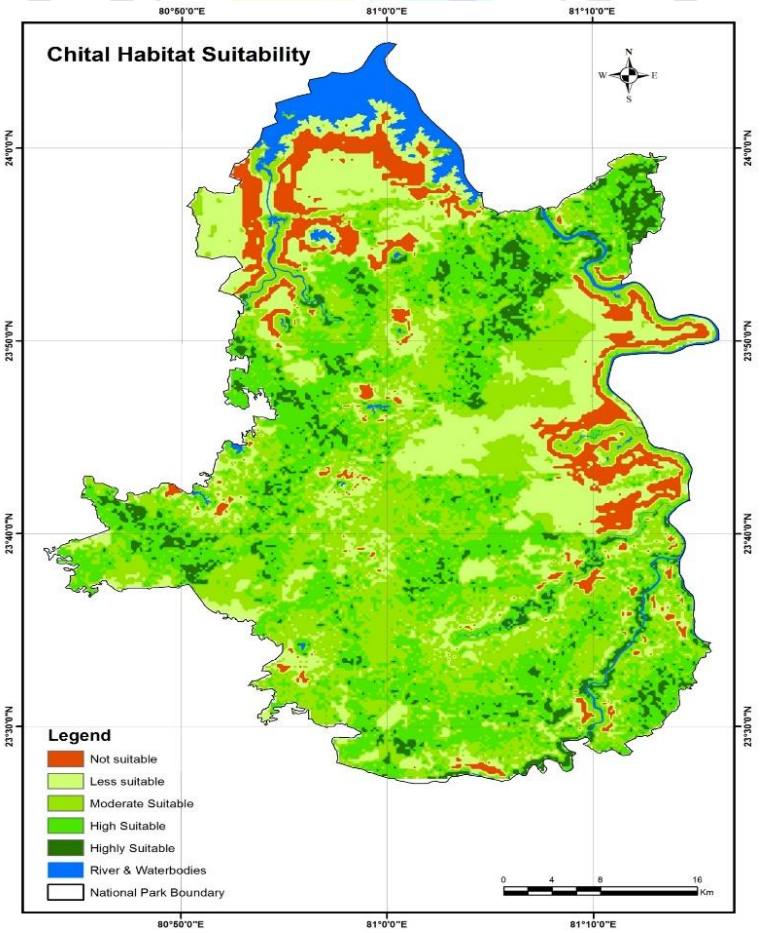


Figure 3**:** Habitat Suitability Map of Chital

Table 2: Habitat distribution of Chital

| Sr. No. | Class | Area in km$^2$ | Area in % |
|---|---|---|---|
| 1 | Highly Suitable | 188.14 | 8.41 |
| 2 | High Suitable | 618.77 | 27.65 |
| 3 | Moderate Suitable | 745.14 | 33.29 |
| 4 | Less Suitable | 508.03 | 22.70 |
| 5 | Not Suitable | 177.89 | 7.95 |

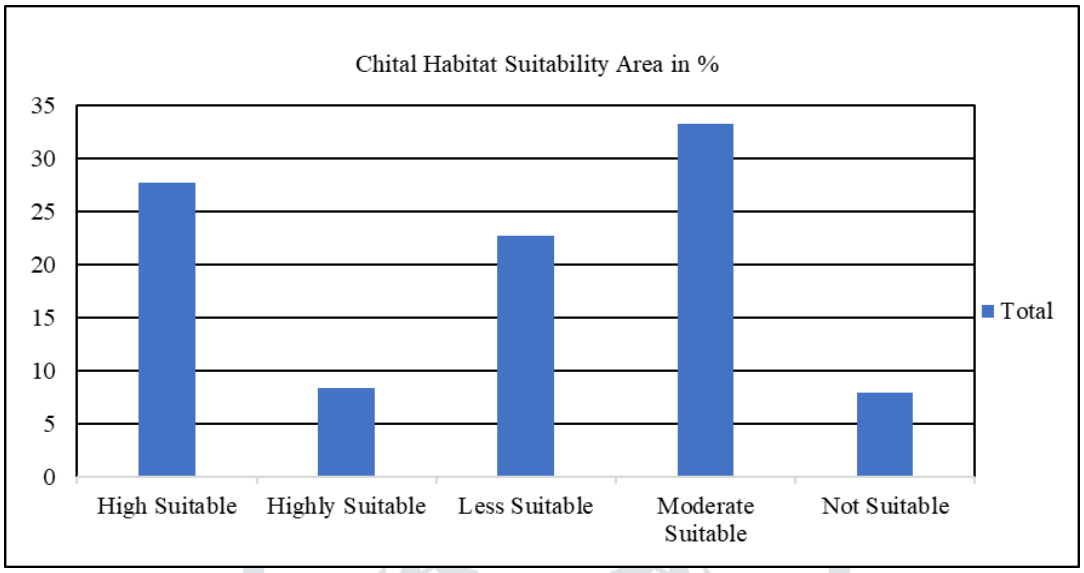


Figure 4**:** Distribution of Chital in different habitat suitability categories

Human settlements areas are usually avoided by wild animals. The denser and more populous an area, the more formidable it is as a movement barrier. Within the forest habitat show preferences for different habitat conditions imposed by the structure and composition of forest. An area having a high density of road would be avoided by wild animals as compared to an area with few or no roads because there is a high traffic and constant noise. This edge effect includes a distinctive species composition or abundance in the outer part of the landscape patch (Forman, 1995). Species like the chital, which prefer edge habitats, generally avoid core areas of areas.

## V. Conclusion

Habitat suitability modeling is the best tools to analysis the suitable site of the particular habitat for the occupancy of wild animals, it depends on the environmental conditions, ecological parameters and availability of food for their survival in the habitats. This study was undertaken to prepare the habitat suitable model for the chital in the Bandhavgarh National Park with the help of remote sensing and GIS tools. The study represents the more suitable sites for the habitat occupancy of chital surrounding of the proximate to water body other than the human settlement. The denser and more populous an area, the more formidable it is as a movement barrier. Within the forest habitat show preferences for different habitat conditions imposed by the structure and composition of forest. An area having a high density of road would be avoided by wild animals as compared to an area with few or no roads because there is a high traffic and constant noise.

In this study the result is 69% habitat suitability for chital, so indicate that the area of national park is good for chital habitat. The use of habitat suitability modeling to identify potential chital habitat needs time and analysis efforts. However, it is an effective and profitable strategy of conservation planning. This study identified potential chital habitat areas by producing a habitat suitability map.

## Reference

1. Eastmen J. R. Idrisi Andes. Guide to GIS and Image Processing. Manual Version 15. *Clarke Labs. Clarke University*, Worcester, MA, USA (2006).
2. Forman, RTT. And Collinge, SK. The ‘spatial solution’ to conserving biodiversity in landscapes and regions. In Conservation of Faunal Diversity in Forested Landscapes. In press. Edited by R.M. De Graaf and R.I. Miller. Chapman and Hall, London, (1995).
3. Karwariya, S.K.,“Study on Site suitability of habitat using remote sensing and GIS-: A case study of Achanakmar - Amarkatak biosphere reserve.” Remoe Sensing and GIS division, Department of Physical Sciences, Mahama Gandhi Chirakoot Gramodaya University, India PhD thesis, (2014), pp.1-155.
4. Karwariya, S.K., Tripathi, S., Daiman, A. **“**Geo spatial approach for tiger habitat suitability mapping: a Case study of Achanakmar - Amarkantak biosphere reserve” *International Journal of Recent Scientific Research*, Vol. 8, Issue, 10, (2017), pp. 21220-21226
5. Pearce, J. L. and Boyce, M. S. Modelling distribution and abundance with presence-only data. *Journal of Applied Ecology* 43, (2006), pp.405-412.

6. Schaller, GB. The Deer and the Tiger. The University of *Chicago Press*. Chichago. (1967), 370pp.
7. Singh, G., Velmurugan, A. and Dakhate, M.P. Geospatial Approach for Tiger Habitat Evaluation and Distribution in Corbett Tiger Reserve, India, *J. Indian Soc. Remote Sens.* 37, (2009), pp.573–585.
8. Singh, R., Joshi, P.K., Kumar, M., Dash, PP. and Joshi, BD. Development of tiger habitat suitability model using geospatial tools: a case study in Achankmar Wildlife Sanctuary (AMWLS), Chhattisgarh India. *Environmental Monitoring and Assessment*, 155, (2009), pp 555–567.
9. Store, R. and Kangas, J. Integrating spatial multi-criteria evaluation and expert knowledge for GIS-based habitat suitability modelling. *Landscape Urban Plann.* 55 (2), (2001), pp. 79-93.
10. Singh, P., Patel, UP., Patel, N. and Patel H. Studies on Biodiversity of Bandhavgarh National Park Umaria (M.P.) With Special Reference to their Ecology. *Golden Research Thoughts*, Volume 4, Issue 6, (2014).
11. Sunquist, M. E. and Sunquist, F. C. Wild Cats of the World. *University of Chicago Press, Chicago, USA,* (2002), pp.345-372.