Original Research Article

Spatial Distribution and Suitable Habitats of Feral Horses in Dibru Saikhowa National Park cum Biosphere Reserve: A Study using Geospatial Technologies

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Abstract: Identifying spatial distribution status and assessing suitable habitats of animal species are important prerequisites for its conservation and habitat management. Dibru Saikhowa National Park cum Biosphere Reserve is the one of few known places in India where feral horses are found. A study was carried out to investigate their spatial distribution and thereafter to find their suitable habitats using geospatial technologies. Unsupervised classification was executed over Landsat 8 OLI image to understand the land use land cover of the study area. Ground Control Points collected using GPS device were attributed with biological data, thus formed the point layer, that has been interpolated to assess the spatial distribution of feral horse herds. Suitable habitats were identified using Weighted Overlay Method. Field observation and secondary data has also been considered to set the final weightage. The study area is dominated by semi evergreen patches, scrub and open forests, salix, swamps and grasslands. Feral horses (around 150-160 individuals) were estimated, and found to be distributed in partially connected small river islands called *chaporis*, mostly dominated by grasses mixed with *Tamarix dioca* and other non-grass species. The area is threatened by severe riverine pressure, human interference and livestock grazing. Geospatial tools are important for modelling of wildlife habitat with less human effort, cost and time. The output of the study is a scientific documentation having scope of further extension, and it will be useful for conservation of Indian feral horses in particular habitats.

Key words: Chapori, Dibru saikhowa, Feral horse, Habitat, Spatial distribution, Weighted overlay.

Introduction

Feral horses (*Equus ferus*) are large bodied mobile grazers adapted to a range of flexible physiological, behavioral and morphological attributes that have enabled them to thrive under a wide range of ecological conditions (Beever, 2003). Feral horses usually live and move in groups, known as herds. Each herd usually consists of 3-5 individuals, but sometimes 12-15 individuals may also occur (Berman, 2008). Feral horses mostly prefer grassy river flats, forest and woodland habitats (Lenehan, 2010). They use open areas where predators can be seen from a distance. Studies have suggested that these animals occur commonly within 5-6 km range of water. Availability of feral horses has been reported from many countries across the world. In India, however, the only known place where feral horses are found is Dibru Saikhowa National Park cum Biosphere Reserve (hereafter referred as DSNP-BR). These horses are the offspring of the army horses left

after the World War II (North East News, 2020). Feral horses are locally known as *Janghali Ghura* or *Bonoria Ghura*. After the massive earthquake of 1950, these animals remain trapped in the floodplain island of Dibru Saikhowa (Bhuyan, 2011). However, there is no scientific documentation available about the Indian feral horses.

Geospatial technology plays an important role for monitoring and conservation of biodiversity as well as in habitat management. Biological database along with ground data can be mapped and incorporated geographically to decide conservation priorities for a particular species (Manel *et al.*, 2001; Salem, 2003). Use of GPS devices has greatly enhanced wildlife researches and conservational activities with better accuracy (Cagnacci *et al.*, 2010). With gradual development in geospatial technologies, the collection and analysis of field data and its prediction has become much easier and effective (Sonti, 2015). Information acquired from remote sensing data supported by field evidences of the presence of animal species have been proved versatile for wildlife habitat suitability analysis (Roy, 1993; Roy and Ravan, 1994). LULC of a particular area is prepared using satellite data and then the known habitat preference and environmental conditions of the species based on ground observation are evaluated. The qualitative ratings in each information layers can be modeled to develop habitat suitability maps (Ejigu, 2016).

The present study was carried out with aim to investigate the spatial distribution status of feral horses in DSNP-BR and to identify their suitable habitats using various tools of Remote Sensing and GIS. The outcome of the study is a baseline documentation on Indian feral horses.

Materials and methods

Study Area

The present study has been carried out in DSNP-BR situated in flood plain areas of the river Brahmaputra, towards eastern corner of the state of Assam, India. The park extends between 27°30¹3ºN – 27°47¹30º N latitude and 95°10¹16ºE – 95°45¹10º E longitude covering an area of 340 sq. km. The area is bounded by mighty Brahmaputra and Siang in the north, Lohit, Dibang and Noa Dihing in the east and Dibru in the south (Figure 1). The elevation of the area ranges from 110m to 126m with an average of 118m. The area experiences tropical monsoon with long, hot summer and short, cool winter. Annual average rainfall is 2300 to 3800 mm (Choudhury 1998). The area is mostly dominated by semi-evergreen forests, grasslands, salix-swamps and scrub forests disturbed by human activities.

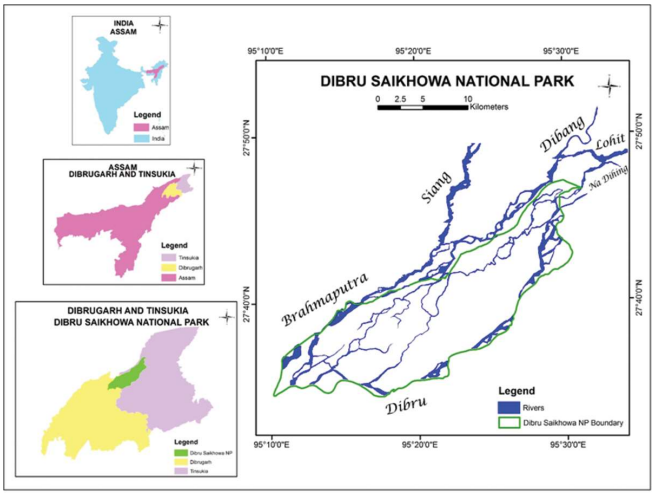


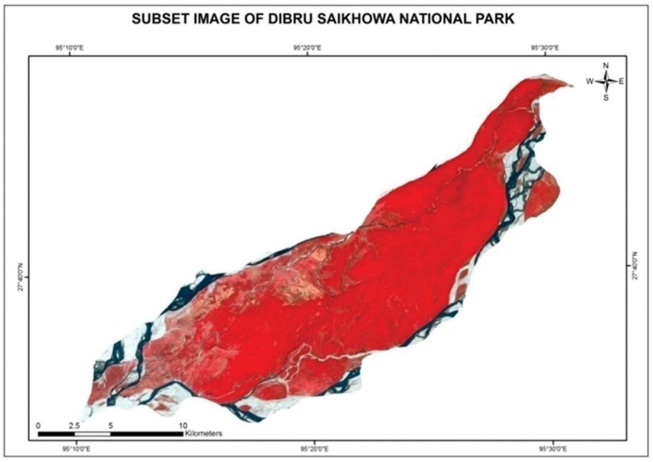
Fig. 1. Location map of DibruSaikhowa National Park. This figure shows where the study area (i.e. DibruSaikhowa National Park) is located and what are the major rivers surrounded the park.

Land Use Land Cover classification and habitat mapping

It is necessary to understand the landscape with proper identification of its features for wildlife habitat studies and its management. Several information about the earth surface can be extracted from remotely sensed satellite images. In the present study, Landsat 8 OLI satellite image with 30m spatial resolution and 134/41 (Path/Row) procured from USGS Glovis was used to classify the study area. Unsupervised classification technique was executed on the subset area of interest (AOI) to extract meaningful classes of interest using ISODATA classification algorithm in ERDAS Imaging. Unsupervised classification provides clusters of pixels with similar spectral characteristics that have to be interpreted into meaningful classes of interest (Jensen, 1996). In a very heterogeneous area with complex spectral variations, unsupervised

LULC category	Image	Tone	Texture	Shape	Pattern	Description
Semi evergreen forest		Dark to Light red	Medium	Irregular	Contiguous	*Mixed of evergreen & moist deciduous forests*
Scrub		Light red or pinkish red	Coarse	Varying	Scattered	*Bushy vegetation with shrubs or scattered trees with density <10%; exposed ground surface*
Grassland		Greyish to brown	Smooth	Irregular /Varying	Scattered	*Dominated by short & long grass species*
Agriculture		Pinkish/ light green	Medium	Usually regular/ Varying	Usually contiguous	*Crops, fellow lands mixed with small to medium sized settlements*
Water bodies		Blue to dark blue	Smooth	Irregular / Linear	Scattered	*Any water body, lakes, river, etc.*
Builtup		Cyan to light Brown	Varying	Regular/ Irregular	Scattered	*Human inhabited areas surrounded by agricultural lands*
Sandy area		Whitish	Smooth / Medium	Irregular	Contiguous /Scattered	*Dry sand bars*

Fig. 2. Interpretation keys for LULC classification. This figure shows the sample pixels taken from the original subset satellite image to classify each LULC category. Based on the pixel characteristics and ground knowledge, the final LULC map of the study area has been prepared.



Note: Images shown against each LULC category in Figure 2 represents sample of pixels taken from the original subset satellite image of the study area. Based on pixel characteristics and ground knowledge, the final LULC of the area has been prepared.

classification provides accurate result (Rozenstein and Karnieli, 2011). The classified image was filtered using a neighbourhood majority function with 3×3 matrix. Recoding was performed for misclassification of features based on ground knowledge and very high resolution image from Google Earth. Landsat image was interpreted using some important interpretation keys (Fig. 2).

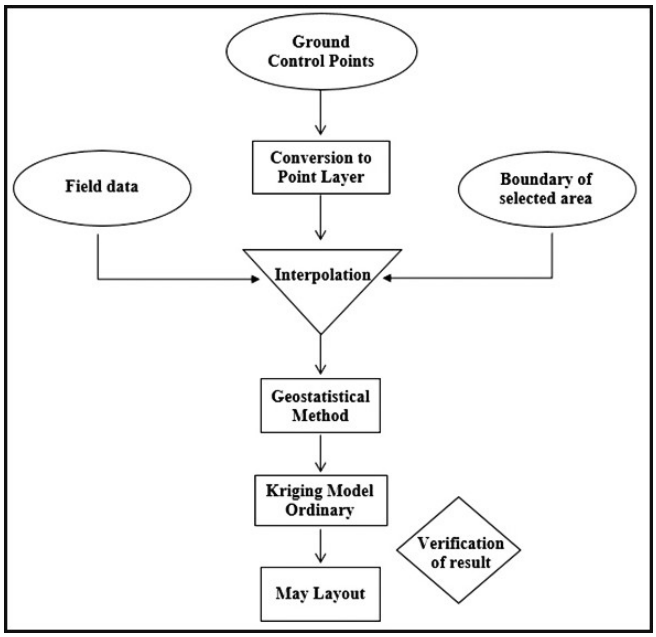


Fig. 3. Flow chart of Kriging Interpolation method. This figure shows the overall procedure adopted to interpolate a raster surface from collected ground points. Interpolation process allow to estimate and predict unknown value from a known geographic point data within a specified distance. This method was adopted to estimate the spatial distribution of feral horses in the study area.

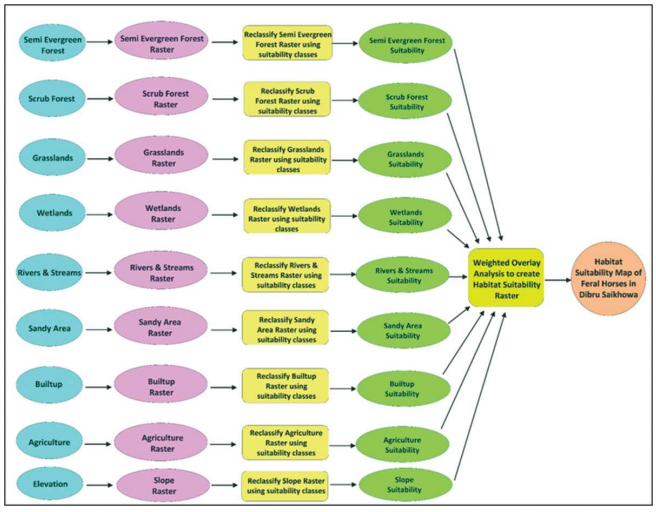


Fig. 4. Flow chart of Weighted Overlay Analysis. This figure shows the overall procedure adopted to identify suitable habitats of feral horses. The LULC classes were converted to raster layers and then assigned each class with some predetermined weights. Various parameters were considered to evaluate suitable habitats. All reclassified raster files were added in weighted overlay tool with correct scale value to identify suitable habitats.

Estimation of spatial distribution of feral horses

Interactions with local people and forest staffs; and extensive field survey using GPS device was conducted to record the

locations of feral horses. During the field survey, the number of herds encountered, number of individuals found in each herd, their movement, daily activities, the type of habitat where they are found, etc. was periodically observed and recorded accordingly. GPS locations were collected wherever feral horses were encountered. Every ground control point (GPS location) was attributed with the biological data collected through physical observations. The ground locations collected using GPS thus formed the point layer that was interpolated using the Kringing Ordinary with spherical semivariogram model (Fig. 3) to generate a continuous surface of spatial distribution of feral horses within the study area.

Analysis of suitable habitats

Spatial decisions involve a large set of datasets, parameters and different alternatives. Accordingly, many spatial problems give rise to GIS based Multicriteria Decision Analysis (MCDA) or Multicriteria Evaluation (MCE) (Malczewski, 2006). MCE was performed using a raster based map algebra expression. Important factors like available food resources, distance from water bodies, habitat type, anthropogenic disturbances, highlands, etc. were considered to evaluate suitable habitats (Talukdar *et al.,* 2020). All vector files were converted to raster and then reclassified using reclassify tools. LULC classes were assigned with certain predetermined weights (1= *Not Suitable*, 2= *Least Suitable*, 3= *Moderately Suitable*, 4= *Suitable* and 5= *Highly Suitable*). The reclassified raster files were added as input in weighted overlay tool with equal and correct scale values. Thus, the suitable habitat sites were identified after performing Weighted Overlay analysis in ArcGIS (Fig. 4).

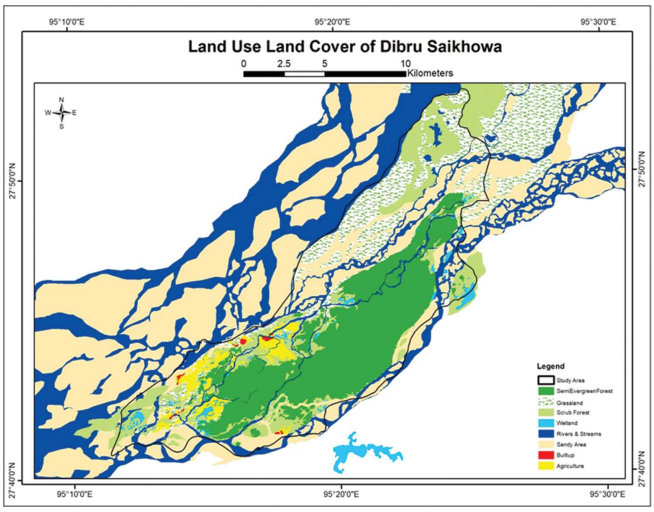


Fig. 5. Land Use Land Cover of DibruSaikhowa. In this figure, the major land use land cover types found in and near DibruSaikhowa has been represented. This help to understand the overall landscape of the study area and to know the type of habitat present with visual information.

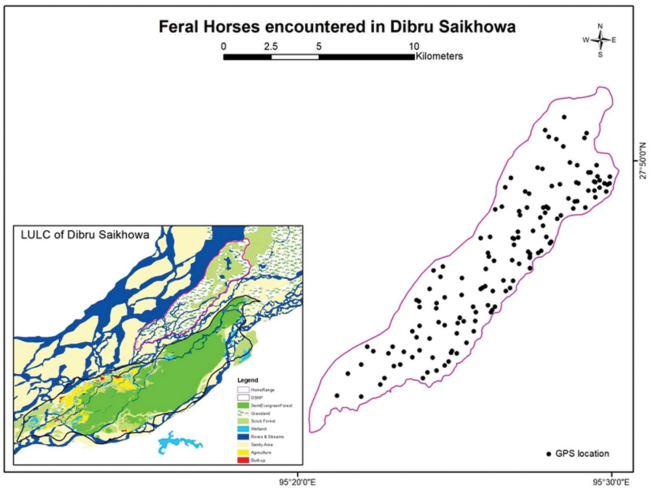


Fig. 6. GPS locations of feral horses encountered during the study. In this figure all those locations are show where feral horses were encountered during the filed survey. Every location was collected using a GPS device. Total of 144 times feral horses were encountered at different locations.

Results

Land Use Land Cover of the study area

The study area is dominated by semi evergreen forests which consist of evergreen forests along with some patches of moist deciduous forests. Scrub forests are found at the peripheries of dense forests and located closer to horse habitations. These areas are open type with biotic as well as abiotic interferences. There are grasslands mixed with *Tamarix dioca* and other non-grass species. Wetlands are found in the form of small ponds or beels. Rivers and streams are also found. Sandy areas are found along river beds. Rural builtup consisting of two forest villages viz. Laika and Dadhia along with agriculture including all types of farm lands are found in the study area (Fig. 5).

Spatial distribution of feral horses

Feral horses were recorded towards northern and north eastern portion of the reserve. The horses were found to stay

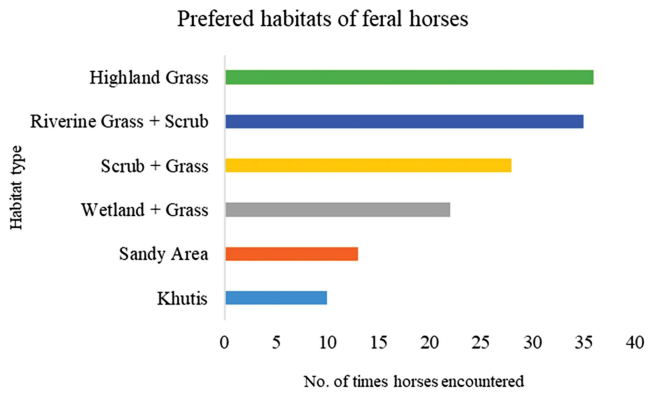


Fig. 7. Preferred habitats where feral horses were found. This figure represents the number of times feral horses are encountered in a particular type of habitat during the study. The figure clearly reflects the preferred habitat types. Horses were maximum found in grassland and riverine habitat.

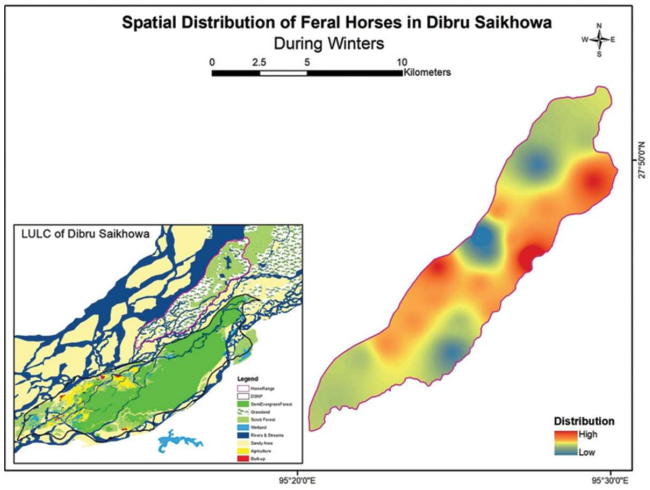


Fig. 8. Spatial distribution of feral horses during winters. This figure shows where feral horses are distributed in winter months during the study. The spatial distribution was developed from Kriging Interpolation. The blue portions show places with less distribution, and towards red portions their distribution gradually increases.

in groups of 3 to 9 individuals. However, on few occasions, single individual was also recorded. 144 times feral horses were encountered at different locations (Fig. 6). Some herds were found to share common area and they follow similar movement. During the study no feral horses were found in dense forest areas. Ten times horse herds were found near cattle farms (locally called as *khuties*). Thirteen times these animals were found in dry river beds completely dominated by sand. Their availability gradually increases near water bodies and grasslands. Twenty-two times found in wetlands dominated by different grass species; and twenty-eight times found in the areas mostly dominated by *Tamarix dioca* and short grasses. However, maximum horse herds were found in riverine grasslands mixed with *Tamarix dioca* and other shrubs (thirty-five times), and thirty-six times in open highland areas (Fig. 7). The horse herds were mostly found distributed in open areas dominated by riverine grasslands mixed with *Tamarix diocea* and other non-grass and shrub species, specially between the rivers Brahmaputra, Siang and Dibang.

Interestingly, feral horses show different distribution pattern in different seasons. As shown in the Figure 7 and 8, red portions are the areas where maximum horses were found and they were distributed closely. On the other hand, their numbers and distribution gradually decreases towards blue portions. During the study it was found that horse herds were distributed widely during winters (Fig. 8). There is scarcity of grasses and other plants in winters. Moreover, they can easily move across their habitat for grazing and other activities. Another important reason is that horses frequently visit near *khuties* in search of food and salts. On the other hand, during summers, the horses were found to be distributed mostly along the bank of Dibang (Fig. 9). There is easy availability of food plants. Moreover, horses cannot move to long distance due to flood.

Suitable habitats

Horizontal and vertical study of natural habitat across the landscape for any wildlife species is very crucial in wildlife ecology. It is essential to know about the requirements for food, water, reproduction, pray-predator relation, competitors, etc. The suitability of habitats was categorised into five levels of suitability (Fig. 10). The study reveals that, open highland grasslands are highly suitable habitats (represented as green portion). Riverine grasslands mixed with *Tamarix dioca* and other shrubs are suitable habitats (represented as lemon green portion). Riverine beds, near water bodies and also those areas near to *khuties* are moderately suitable habitats (represented as yellow portion). Areas near human settlements, agricultural activities and mixed cultivation are

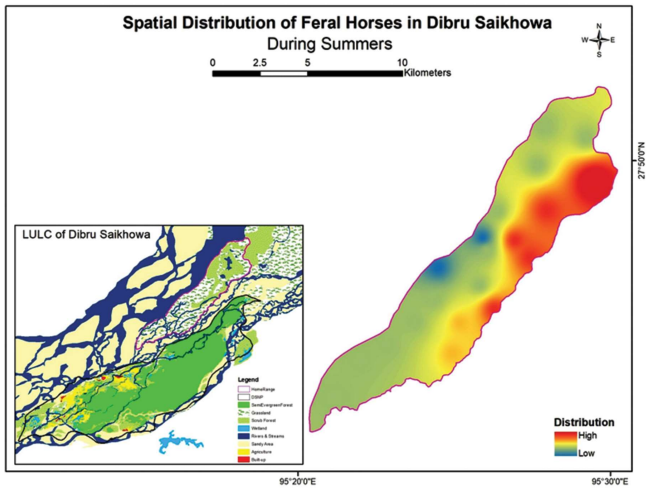


Fig. 9. Spatial distribution of feral horses during summers. This figure shows where feral horses are distributed in summer months during the study. The spatial distribution was developed from Kriging Interpolation. The blue portions show places with less distribution, and towards red portions their distribution gradually increases.

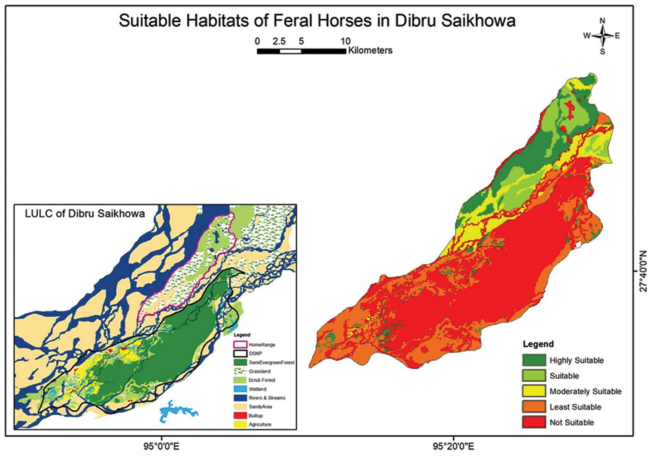


Fig. 10. Suitable habitats of feral horses in DibruSaikhowa. This figure shows the suitable habitats of feral horses in the study area. The area is categorized into five levels of suitability. Red portions are not suitable habitats, and towards green portions suitability gradually increases.

least suitable habitats (represented as orange portion). While dense forest areas are found as not suitable habitats (represented as red portion).

Discussion

There is no readily available scientific database on Indian feral horse. Therefore, the present study has tried to establish

Fig. 11. Feral horses observed in different habitat conditions in DibruSaikhowa. This figure shows various types of habitat condition where feral horses are found in the study area.

(i) a horse herd in sandy area in ArnaTapu

(ii) a male horse in river bank near KobuChapori

(iii) a horse herd grazing in grasslands at Churketapu

(iv) a horse herd in wetland near Meili Camp

a baseline documentation on population status, spatial distribution and suitable habitats of feral horses in DSNP-BR which is considered as the only known habitat of this creature in India. Feral horses stay in groups of 3 to 7 or sometimes more individuals. Around 150-160 individuals have been estimated during the study. The herds mostly prefer to stay and move in open areas where predators can be seen easily. However, movement and distribution of horse herds depend on their daily activities. In early part of the day herds are mostly found in open riverine grassland areas. During noon time they are mostly found under bushy shrubs, and towards afternoon and evening period they usually visit near waterbodies and swampy areas dominated by different grass species. Much of the time they spent in grazing. Open highlands and riverine grasslands are most preferred habitats. Horses are equally found near grazing lands and local cattle farms called *khuties*. Suitable habitats are found mostly in and near *chapori* or *tapu* areas like Churke Tapu, Arna Tapu, Kathalkuthi near Mieli Camp, Kobu Chapori, and other nearby areas where habitat is mostly dominated by riverine grasslands mixed with some shrubs species (Fig. 11). However, areas with regular human interventions and dense

vegetation are least preferred by feral horses. Brahmaputra, Siang and Dibang flow as a natural barrier between the identified home range and the rest of the world. Annual flood, severe erosion along with livestock grazing has been identified as major threats to their habitat. In addition, various human activities and cattle farms cause destruction of habitat into smaller fragments. Cattles are found to be major competitors resulting in excessive grazing in grassland habitats.

Geospatial technology in wildlife sciences is an effective tool for managing, analyzing and mapping of wildlife data that offer solutions for planning, problem analysis, monitoring and conservation of wildlife. The output of the present study has been represented in the form of maps, which will help in easy understanding with better visual information about the landscape pattern of the study area, major forest types, seasonal distribution of feral horses and their suitable habitats, etc. Such readily available information is helpful for the park management. Moreover, satellite images of different time periods along with periodic ground monitoring can reveal about the dynamic changes occurring in the preferred habitats of feral horses in the study area. Since, feral horses are found only in DSNP-BR, therefore, it is of prior necessary to carry out some scientific studies, create database, and conserve this beautiful animal. The study has scope for further extension of scientific analyses and predictions in this area and beyond.

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