Assessment of habitat utilization pattern of rhinos *(Rhinoceros unicornis)* in Orang National Park, Assam, India

Pranjit Kumar Sarma,[1,] B.S. Mipun,[3] Bibhab Kumar Talukdar,[2] Hilloljyoti Singha,[2] Ajit Kumar Basumatary,[2] Arup Kumar Das,[2] Ankita Sarkar[2] and B.C. Hazarika[1]*

[1] Mangaldai College, Mangaldai, Darrang, 784125, Assam
[2] Aaranyak, 50 Samanwoy Path, Survey, Beltola, Guwahati 781028, Assam
[3] Dept. of Geography, North-Eastern Hill University, Shillong 793 014, Meghalaya
*Corresponding author email: prangis@gmail.com

Abstract

The greater one-horned rhino is performing well in Orang National Park (NP), Assam, despite threats from poaching, which is regarded as one of the major threats to rhinos elsewhere. Orang NP has about 64 rhinos in an area of about 78.80 km^2. Habitat assessment is important to support rhino conservation, especially considering the threats posed by the increasing spread of mimosa, a weed that retards the growth of grasses and destroys the grassland habitat that rhinos prefer. This paper deals with habitat utilization by rhinos in Orang NP, which shows the importance of wet grasslands that are dependent on hydrology and flooding dynamics.

Additional key words: habitat, threats, grassland

Résumé

Le grand rhinocéros unicorne se porte bien dans le Parc National d'Orang dans l'Assam, malgré les menaces de braconnage, considéré comme l'une des principales menaces qui pèsent sur le rhinocéros ailleurs. Le PN d'Orang a environ 64 rhinocéros sur une superficie d'environ 78,80 km^2. L'évaluation de l'habitat est importante pour appuyer la conservation des rhinocéros, surtout compte tenu des menaces posées par la propagation croissante de mimosa, une mauvaise herbe qui retarde la croissance des graminées et détruit l'habitat des herbages préférés par les rhinocéros. Ce document traite l'utilisation de l'habitat par les rhinocéros au PN d'Orang, ce qui montre l'importance des herbages humides qui dépendent de la dynamique de l'hydrologie et des inondations.

Mots clés supplémentaires : habitat, menaces, herbages

Introduction

Habitat management is key to supporting pre-historic wild animals like the rhino. Individuals or groups of wild animals never use the entire habitat homogenously, but utilize selective zones of the habitat (Hazarika, 2007). Each species requires a particular habitat, food, shelter and other survival needs, to the extent that species are said to be a product of their habitat (Smith, 1974). This habitat selection could be determined by the availability of food resources, mate distribution as well as safety from predators (Fjellstad and Steinheim, 1996). There are species-specific variations of habitat use patterns owing to distinct food choices of individual species, which may or may not be available in each habitat patch and home range area (Bell, 1971). The differences in food choice lead to variations in habitat utilization patterns among different species; it is widely applicable among herbivorous animals. The seasonal variation of food availability, such as burning of grasslands and annual floods, affects the variation of habitat utilization pattern of herbivorous animals

(Lahan, et al. 1971; Debroy, 1986; Hazarika, 2007).

Information regarding the habitat utilization pattern of the greater one-horned rhino in Orang National Park (NP) is very limited. The lone study on this aspect was carried out by Hazarika (2007) in Orang NP. Sarma et al. (2011) carried out a GIS-based habitat suitability modelling and assessment of the greater one-horned rhino in Orang NP, but not on its habitat utilization pattern in the park. Bhattacharya (1982, 1992) describes the home range and daily movement pattern of the Indian rhino at Jaldapara Wildlife Sanctuary, Gorumara NP and West Bengal, and Orang NP of Assam. Chowdhury (1966), Brahmachary et al. (1969), Dinerstein and Wemmer (1988) and Dinerstein (1991) studied the food habits and seed dispersal pattern of the Indian rhino in India and Nepal. Bairagee (2004) describes the food preferences of the Indian rhino in the grassland habitat of Pabitora Wildlife Sanctuary (WLS) of Assam, while Talukdar et al. (2007) studied rhino straying routes in Pabitora WLS and Sarma et al. (2009) made an attempt to assess the habitat change and threats to the greater one-horned rhino in Pabitora WLS using multi-temporal satellite data. Fjellstad and Steinheim (1996) studied the Indian rhino's diet and habitat use during the dry season in Royal Bardia NP of Nepal. Dinerstein and Prince (1991) studied the demographic and habitat use pattern of the Indian rhino in terai grassland habitat. Kushwaha et al. (2002) studied the landmass dynamics and habitat suitability analysis for the Indian rhino in Kaziranga NP of Assam. A brief description of the behaviour and habitat utilization pattern of the Indian rhino was described by Gee (1953a,b). Mary et al. (1998) studied the feeding and territorial behaviour of the Indian rhino in Kaziranga NP of Assam.

Materials and methods

Study area

Orang NP covers an area of 78.8 km^2. It is located on the north bank of River Brahmaputra within the administrative boundary of Darrang and Sonitpur Districts of Assam, India. It lies within the geographical limits of 26′29″N to 26′40″N latitude to 92′16″E to 92′27″E longitude. This park enjoys a floodplain ecosystem and is a prime habitat for other important species of conservation importance like the royal Bengal tiger, the Asiatic elephant and different deer species. The park has often been regarded as an artificially made forest. Figure 1 shows the geographical location of Orang NP.

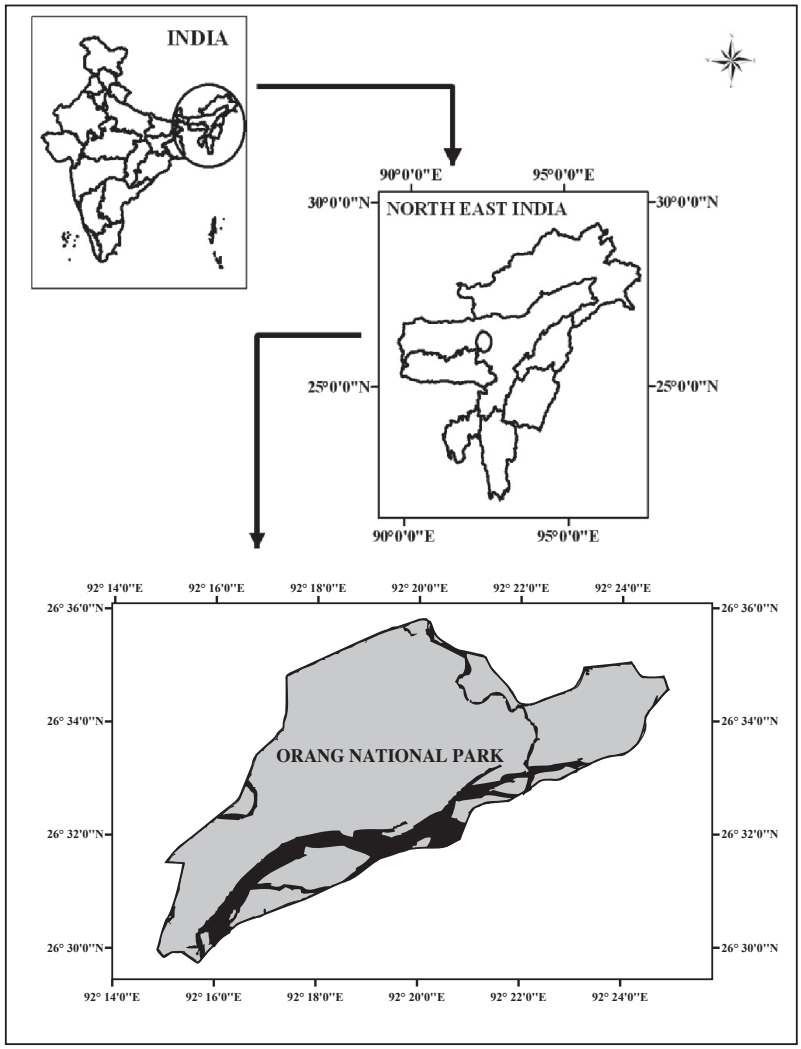

Figure 1. Location of Orang National Park.

Method

A direct method of monitoring the movement of the one-horned rhino was used (Laurie, 1978) to determine the seasonal variations of the pattern by which the rhinos use their habitat in Orang NP. The tall grasses and dense woodland of the park make observation difficult, particularly during the monsoon season when much of the study area is flooded. Observers went on foot, on elephant back and on field vehicles to watch the rhinos. Ability to sight the rhinos changed by season, depending on the height of the grass and the frequency of rhinos wallowing in open swamps.

The entire study area was divided into 18 blocks, based on different habitat types, camp locations and resources available such as trained elephants. A continuous ground survey for four different seasons was conducted with the help of trained elephants provided by the Assam government State Forest Department. The survey was carried out in 2008/09 in pre-monsoon (March–May), monsoon (June–September), retreating monsoon (October–November) and winter (December–February) seasons to get the seasonal variation of habitat use. A map was prepared before starting to collect primary data. The blocks were distributed to members of the team to avoid overlapping of blocks while surveying.

The study started at 0600 h and was completed at 1000 h each day in each block to minimize errors while collecting data. A data sheet was maintained to note down the date of survey, habitat pattern, vegetation species and number of rhinos counted. At the end of data collection, these block data were entered into a GIS domain to analyse and form a habitat utilization pattern map for different seasons.

At least 64 rhinos were observed 183 times throughout the study period in different habitat types in the park. Chi-square goodness-of-fit statistical analysis was carried out for all 183 rhino sightings to understand the pattern significance.

Results and discussion

Habitat utilization pattern of rhinos in 2008/09

During the study period between September 2008 and September 2009, rhinos were spotted at least 183 times in different habitats in Orang NP. The 2009 census of the Environment and Forest Department put the rhino population of Orang NP at 64. During this study period, the 64 rhinos were sighted 183 times in the park in different habitats throughout the year. Thus the study reveals that the maximum use of wet alluvial grassland habitat by the Indian rhino was 59.56% (n = 109), 24.59% (n = 45) in the dry savanna grassland, 13.11% (n = 24) in woodland habitat and 2.74% (n = 5) in wetland habitat.

Earlier studies carried out on habitat utilization patterns, ecology and behaviour of the greater one-horned rhino also show that the habitat the rhinos prefer most is wet alluvial grassland (Fjellstad, et al., 1996; Deka et al., 2003; Laurie, 1978). The chi-square goodness-of-fit analysis also shows that, irrespective of seasons, the significantly highest number of rhinos was sighted in wet alluvial grassland habitat (X^2 = 134.09, df = 4, $p < 0.01$).

The highest number of rhinos was sighted in Satsimalu block (Table 1). Out of 183 rhino sightings, 51 rhinos were sighted in Satsimalu block. The main reason the rhinos concentrated in this block were the availability of fodder, mainly wet alluvial grassland, and a water body for

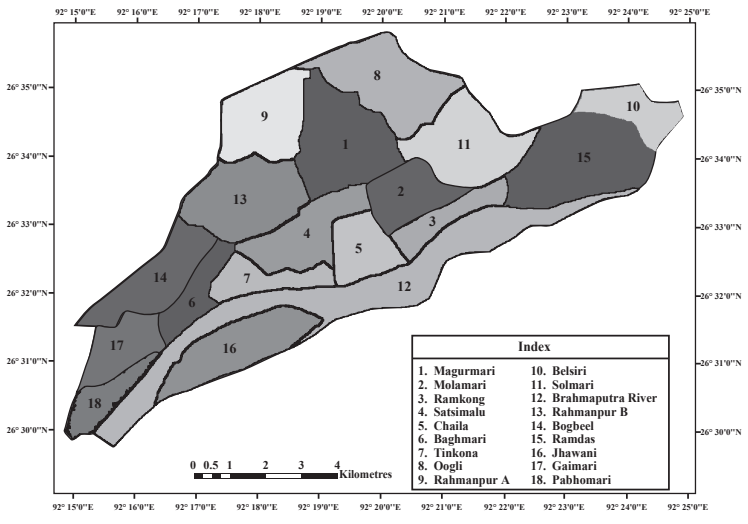

Figure 2. Blocks of Orang NP.

Table 1. Block-wise rhino sighting in Orang NP, 2008/09

Blocks	Sightings (%)	Alluvial grassland (%)
Baghmari	14	34.88
Belsiri	0	22.05
Boogbeel	7	30.02
Chaila	9	45.63
Gaimari	10	40.9
Jhawani	0	28.65
Magurmari	11	37.33
Moalamari	19	41.37
Oogli	10	27.09
Pabhomari	6	51.09
Rahmanpur A	2	14.39
Rahmanpur B	18	23.76
Ramdas	0	36.03
Ramkong	6	32.59
Satsimalu	51	56.69
Solmar	8	26.5
Tinkona	12	31.43
Brahmaputra River	0	1.88

Source: Field data obtained during the survey.

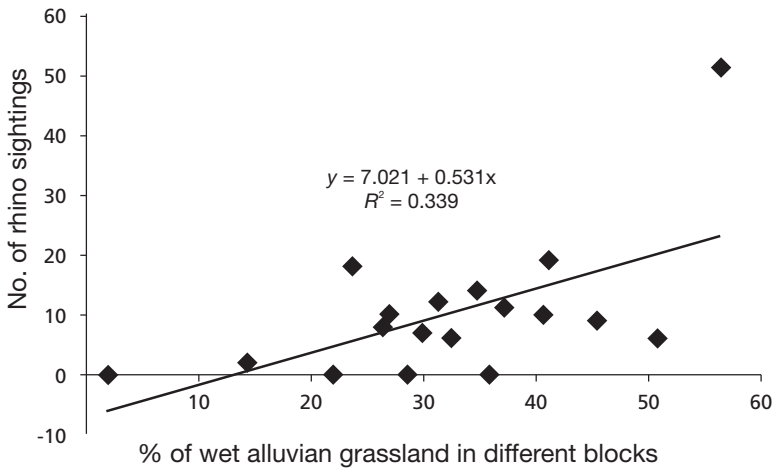

Figure 3. Correlation between wet alluvial grassland and rhino sighting.

wallowing. Table 1 also shows the percentage of wet alluvial grassland in each block.

The results also show that there is a positive correlation between rhino sightings and wet alluvial grassland ($R = 0.582$) in Orang NP. Figure 3 shows the correlation between these two variables, that is, block-wise percentage of wet alluvial grassland and number of rhino sightings. Here, percentage of wet alluvial grassland was considered the independent variable and number of rhino sightings the dependent variable.

Seasonal variation of utilization pattern

The seasonal variation of food availability, burning of grasslands and annual flooding affects the habitat utilization pattern of herbivore animals (Lahan et al., 1973; Debroy, 1986). Rhino, a mega herbivore, changes its pattern of using its habitat according to availability of food, vegetation cover and water in different seasons of the year. In this study, rhinos were monitored in different seasons—pre-monsoon, monsoon, retreating monsoon and winter—by tracking them on trained elephants. The chi-square goodness-of-fit analysis is widely used in statistics (Zar, 2007). The results of the chi-square goodness-of-fit analysis show that there are significant associations between habitat types and seasons in the distribution of rhinos in Orang NP ($X^2 = 16.97$, df = 9, $p < 0.05$). They also indicate that rhinos were scattered in the park according to seasons and habitat, and were sighted in different habitats and seasons. Similarly, irrespective of seasons, large numbers of rhinos were found in wet alluvial grasslands ($X^2 = 134.09$, df = 4, $p < 0.01$) in 2008/09. Rhinos always prefer wet alluvial grassland in Orang NP, an observation also evident from studies done in Nepal and India (Fjellstad, 1996; Deka et al., 2002) and in the ecology and behaviour study of the greater one-horned rhino (Laurie,

1979). Similarly, analysis of habitat utilization pattern of rhinos in different seasons in 2008/09 in Orang NP was carried out to understand the variation in habitat use.

Pre-monsoon season (March–May)

The rhinos used 61.84% of wet alluvial grassland, 22.36% of dry savannah grassland, 15.60% of woodland and 0.20% of wetland habitat during the pre-monsoon season. During this season, a significantly highest number of rhinos was found in the wet alluvial grassland habitat ($X^2 = 63.05$, df = 3, $p < 0.01$).

Monsoon season (June–August)

During the monsoon season, rhino used 48.71% of wet alluvial grassland, 35.89% of dry savanna grassland, 12.82% of woodland and 2.58% of wetland habitat. The highest number of rhinos was sighted in the wet alluvial grassland ($X^2 = 20.79$, df = 3, $p < 0.01$).

Retreating monsoon season (September–November)

During the retreating monsoon, rhinos used 65.62% of wet alluvial grassland, 21.87% dry savanna grassland, 12.50% woodland and 0.01% of wetland habitat. The highest number of rhinos was sighted in wet alluvial grassland ($X^2 = 31.20$, df = 3, $p < 0.01$).

Winter season (December–February)

During the winter, the results show that rhinos used 61.11% of wet alluvial grassland, 19.44% dry savanna grassland, 11.12% woodland and 8.33% wetland habitat. During this period, the highest number of rhinos was sighted in the wet alluvial grassland area ($X^2 = 26.06$, df = 3, $p < 0.01$).

Figure 4 shows the locations in Orang NP where rhinos were sighted during different seasons of the year.

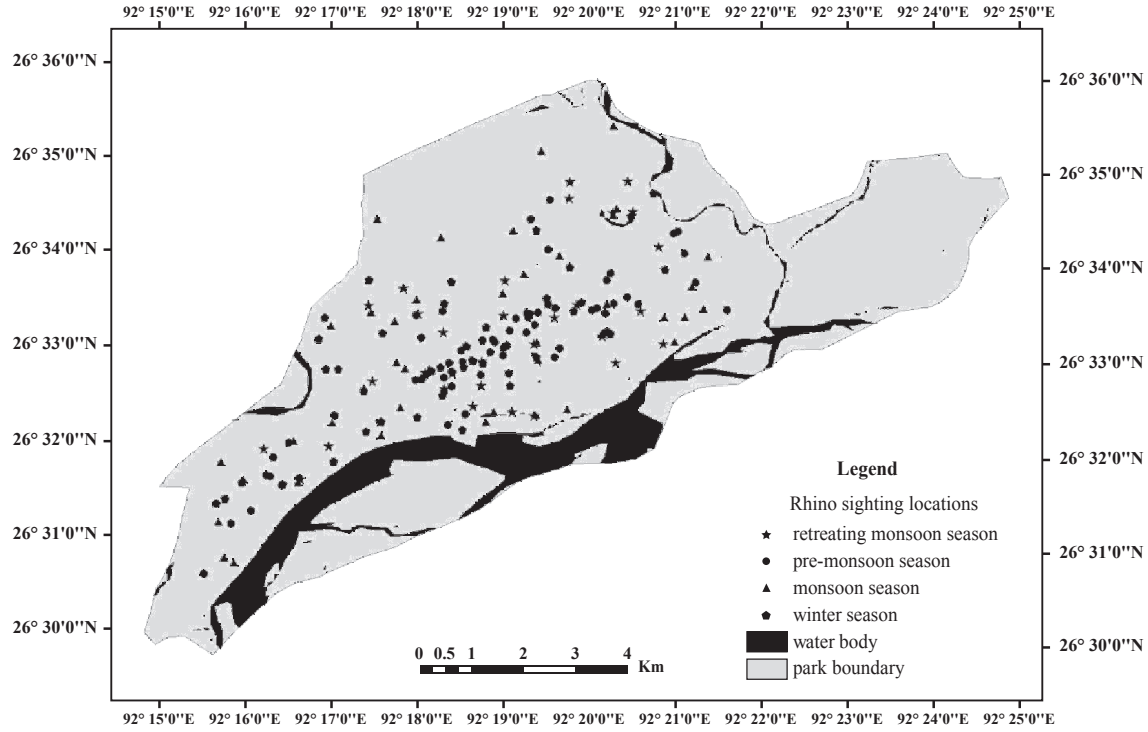

Figure 4. Sighting locations of rhinos in different seasons.

Conclusion

The analysis reveals that irrespective of season, the highest number of rhinos was sighted in the wet alluvial grassland during 2008/09 ($X^2 = 134.09$, df = 4, $p < 0.01$). This indicates that rhinos prefer wet alluvial grassland in all seasons of the year (59.56%). The habitat utilization pattern changes in blocks according to the availability of fodder in the wet alluvial grassland. This study also shows that the habitat utilization pattern of rhinos is dependent upon food, grass cover and water. Keeping in mind rhino preference for wet alluvial grassland, it is essential for management authorities to maintain the hydrology of the park that supports wet alluvial grassland. Siltation due to flooding needs to be checked; de-siltation should also be carried out to maintain wetland dynamics in the park that in turn help in maintaining the wet alluvial grassland that rhinos prefer. Compared with the flood havoc faced by Kaziranga NP or Pabitora WLS where rhinos are also found, Orang NP witnesses less flooding and hence, there are potential opportunities to maintain preferred grassland habitat in the park with timely management interventions to ensure the long-term conservation future of rhinos. The results of this study resemble the study done by Hazarika (2007).

Acknowledgements

The authors are thankful to the principal chief conservator of forests (DFO), Assam Forest Department for permission to carry out the work in Orang NP. The authors also thank Mr Sukumar Momin, ex-divisional forest officer and Sushil Kr. Daila, DFO, Orang NP for their support and encouragement. Special thanks to Mr Jayanta Kumar Deka, ex-range officer of Orang NP. The authors are thankful to all the staff of Orang NP and of Aaranyak, especially Mr Chatrapati Das, Mr Kamal Azad and Dr Firoz Ahmed, for their support and encouragement. Finally, thanks to the Asian Rhino Project and the International Foundation for Science for providing the necessary funding to carry out this work.

References

Bairagee, A. (2004). A study on the population status and conservation approach for *Rhinoceros unicornis* in Pabitora Wildlife Sanctuary, Assam, India. *Tiger Paper* 31(1):11–14.

Bell, R.H.V. (1971). A grazing ecosystem in the Serengeti. *Scientific American* 224 (1):86–93.

Bhattacharya, R. (1982). Daily activity cycle of Greater Indian one-horned rhinoceros at Gorumara and Jaldapara Wildlife Sanctuary in West Bengal. *All India Symposium of Wildlife Biology* 12:1–5.

Bhattacharyya, B.K. (1991). Studies on certain aspect of the biology of the greater Indian one-horned rhinoceros. PhD thesis, Gauhati University. 287 pp.

Brahmachary, R.L., Mallik, B. and Rakshit, B.C. (1969). An attempt to determine the food habits of the Indian rhinoceros. *Journal of Bombay Natural History Society* 67:588–560.

Chowdhury, T. (1966). A note on breeding Indian rhinoceros, *Rhinoceros unicornis*, in Gauhati Zoo. *International Zoo Year Book* 6:197.

Debroy, S. (1986). Fire in tall grassland habitats of Assam. *The Indian Forester* 112 (10):414–418.

Deka, R.J., Sarma, N.K. and Baruah, K.K. (2003). Nutritional evaluation of the principal forages / feed consumed by Indian rhino in Pabitora Wildlife Sanctuary and Assam State Zoo cum Botanical Garden, Assam. *Journal Zoo's Print* 18(3):1043–1045.

Dinerstein, E. and Prince, L. (1991). Demography and habitat use of greater one-horned rhinoceros in Nepal. *Journal of Wildlife Management* 55(3):401–411.

Dinerstein, E. (1991). Seed dispersal by greater one-horned rhinoceros (*Rhinoceros unicornis*) and the flora of rhinoceros latrines. *Mammalia* 55(3):355–362.

Dinerstein, E. and Wemmer, C. (1988). Fruit rhinoceros eat: Dispersal of *Trewia nudiflora* in lowland Nepal. *Ecology* 69:1768–1774.

Fjellstad, J.I. and Steinheim, G. (1996). 'Diet and habitat use of greater Indian one-horned rhinoceros (*Rhinoceros unicornis*) and Asian elephants (*Elephas maximus*) during dry season in Babai Valley, Royal Bardia National Park, Nepal.' MSc thesis, Agricultural University of Norway.

Gee, E.P. (1953a). The life history of the greater Indian one-horned rhinoceros (*Rhinoceros unicornis*).

Journal of Bombay Natural History Society 34(2):341–348.

Gee, E.P. (1953b). Further observation on the great Indian one-horned rhinoceros (*Rhinoceros unicornis*). 51(4):765–772.

Hazarika, B.C. (2007). Studies on the eco-behavioural aspect of greater Indian one-horned rhinoceros (*Rhinoceros unicornis*) in Orang National Park. PhD dissertation, Department of Zoology, Gauhati University.

Kushwaha, S.P.S. (2002). Geoinformatics for wildlife habitat characterization. Proceedings of the 5th Annual International Conference, Map India, New Delhi, pp. 293–302.

Lahan, P. and Sonowal, S.N. (1971). Kaziranga Wildlife Sanctuary, Assam: A brief description and report. Report on census of large animals. *Journal of Bombay Natural History* 70(2):245–278.

Laurie, W.A. (1978). The ecology and behaviour of the greater Indian one-horned rhinoceros. PhD dissertation, University of Cambridge, Cambridge. 450 pp.

Mary, P.O., Solanki, G.S., Limbo, D. and Upadhay, K. (1998). Observation of feeding and territorial behaviour of *Rhinoceros unicornis* in Kaziranga National Park. *Tiger Paper* 25(4):25–28.

Pradhan, N.M.B. and Wegge, P. (2007). Dry season habitat selection by a recolonizing population of Asian elephants *Elephas maximus* in lowland Nepal. *Acta Theriologica* 52(2):205–214.

Rookmaker, L.C. (1982). The former distribution of the Indian rhinoceros (*Rhinoceros unicornis*) in India and Pakisthan. *Journal of Bombay Natural History Society* 80:555–563.

Sarma, P.K., Talukdar, B.K., Sarma, K. and Baruah, M. (2009). Assessment of habitat change and threats to the greater one-horned rhino (*Rhinoceros unicornis*) in Pabitora Wildlife Sanctuary, Assam, using multi temporal satellite data. *Pachyderm* 46:18–24.

Sarma, P.K., Mipun, B.S., Talukdar, B.K., Kumar, R. and Basumatary, A. (2011). Evaluation of habitat suitability for rhino *(Rhinoceros unicornis*) in Orang National Park using geo-spatial tool. *ISRN Ecology,* Vol. 11, doi:10.5402/2011/488258.

Smith, R.L. (1974). *Ecology and field biology*. Harper and Row, New York.

Talukdar, B.K., Sarma, P.K. (2007). *Indian rhinos in protected areas of Assam: A geospatial documentation of habitat change and threats. Published by* Aaranyak. Online publication www.aaranyak.org/reports-books.

Zar, J.H. (2007). *Biostatistical analysis*. 4th edition. Dorling Kindersley India Ltd., pp. 462–464.