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Full Length Research Paper

Wildlife use of Bharandabhar forest corridor: Between Chitwan National Park and Mahabharat foothills, Central Tarai, Nepal

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Barandabhar forest is a wildlife corridor connecting Chitwan National Park and Mahabharat foothills in Nepal's Inner Tarai. Chitwan harbors the largest population of the great one-horned rhinoceros (*Rhinoceros unicornis* L.) in Nepal. Barandabhar forest serves as a highly potential alternative habitat to enable wildlife to move up to Mahabharat foothills mainly during the rainy season. The whole forest area was divided into four blocks from south to north and sampled plots along 1.5 km length transects spaced at intervals of 250 m apart for wildlife and disturbance signs. Wildlife signs were higher near the National Park (ANOVA, P < 0.001; Tukey's HSD, P <0.05). Disturbance signs were lower near the National Park and the Mahabharat Foothill forests and highest in the central part of the corridor. Wildlife signs were also affected by the distance of a sample plot from the edge of the corridor (ANOVA, P = 0.032), while disturbance signs were similar irrespective of the distance of a sample plot from the edge of the corridor (ANOVA, P = 0.56). The results illustrated that the central portion of the corridor near the East-West Highway is the weakest point in the corridor being flanked by the township of Bharatpur Municipality and the relocated village of Padampur.

Key words: Barandabhar, corridor, Chitwan, Tarai, Bishazaari, Padampur, highway.

INTRODUCTION

The lowland Tarai region of Nepal covers about 15% of the total area wherein Chitwan, the central stretch has been famous since time immemorial for its rhinoceros (*Rhinoceros unicornis* Linn.) population that harbored about 1000 animals until 1950 (Gee, 1959). Significant declines in the rhinoceros population were noticed due to the accelerated rate of habitat loss during 1950s when malaria was eradicated and degradation of forest was increased dramatically (Gee, 1963). In addition, several factors contributed to decline in animal populations and deteriorating habitats such as encroachment for human habitation and cultivation, habitat shrinkage, extensive poaching and other human induced activities that led to the fragmentation. With the suppression of malaria, settlement of Chitwan valley was initiated by both spontaneous immigration and planned government resettlement in early 1960s. Chitwan forests, other than those in the National Park had all been converted to human settlements and farmland, as had most of the low-lying forests and remnant patches of forests along the mountain chains (Panwar, 1986). Consequently, Barandabhar forest between Chitwan National Park (CNP) and Mahabharat Mountain range remained the only forest strip connecting two different ecological systems. It serves to function as a wildlife corridor for some animals and alternative or seasonal/and temporal habitat for others ((Litvaitis et al., 1996). The East-West National Highway passes across the Barandabhar forest mid way in the corridor has been highly disturbed spot and is under the most severe human pressure. It is also the weakest link in the corridor due to the township of Bharatpur. This forest has been frequently utilized as a wildlife corridor by mega-herbivores like rhinoceros (*Rhinoceros unicornis)*, carnivores like tigers (*Panthera tigris*) and leopards (*Panthera pardus*), reptiles like mugger crocodiles (*Crocodylus palustris*), waterfowls and

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wintering birds. It also serves as a refuge during the monsoon floods (Kandel, 2003).

Periodic floods occurring in the Rapti flood plain force rhinoceros to move towards the highlands through? these corridor forests (Kandel, 2003). The Barandabhar forest, the north-south narrow strip has a minimum width of about 1.5 km, an average width of 4 km and length of 20 km. It narrows down towards Mahabharat foothills and this area was chosen for studying use by rhino and other wildlife (Picture 1). This strip has been exploited by a variety of wildlife species as a day to day movement path to reach the foothills. The forest patch has been flanked by human habitation along either side and is being degraded and compressed as the anthropogenic pressure increased.

Collections of grass, lopping fodder trees for the livestock, cutting for firewood, livestock grazing are the prominent disturbance factors (Heinen and Kandel, 2006). The only conservation measure taken in this forest until a decade ago was management of a few patches of Community Forest by local communities. Rhinoceros, one of the prominent immigrants frequently moved up to foothills and a small population of around 15 to 20 resident rhinoceros had been found at the uppermost portion of this forest corridor till 1990s (Kandel, 2003). With the relocation of Padampur village to Saguntole at the north-eastern border of Barandabhar forest from the National Park area in late 1990s, this resident rhino population has vanished. This forest corridor is still used seasonally by more than 30 rhinos and 10 different tigers according to recent field studies during the monsoon in 2002 (Bishnu Lama's pers. comm.). This area was previously declared as Mahendra Mrig Kunja (Deer Park) in 1959 (Spillett and Tamang, 1966) before the CNP was designated as the National Park.

There has not been any intensive study of wildlife use in Barandabhar forest to date. The aim of this study is to measure the habitat use by wildlife in this forest so that it would be possible to predict weak links within it which could have significant implications for wildlife management in the future. It is important that the animal presence, distribution and habitat use by animals from CNP in this forest strip are monitored regularly. This study will serve as a baseline for the habitat use by wild animals in the Barandabhar forest. Such short-term studies taken up at regular intervals will update and augment the information used for management.

MATERIALS AND METHODS

Rhinoceros and other animal's use of the Barandabhar forest corridor

To assess rhinoceros and other wildlife use, human and other pressures in the corridor, transects were spaced 1.5 km apart parallel to the corridor. Presence of animals and habitat usage by them was assessed with systematic sample plots of size 2 × 25 m at every 250 m interval on each transect. Indirect evidence like footprints, dung piles, feeding signs, scratch/markings and digging signs were recorded. The distance along the transects was measured with a laser range finder and standard plots were calibrated with nylon rope. A 'silva compass' was used to determine the bearing of the transects and a handheld GPS unit was used to determine the location of the sample plots in the corridor. The wild animal signs which were recorded from the sample plots were rhinoceros, tiger, leopard, sambar (*Cervus unicolor*), spotted deer (*Axixi axix*), barking deer (*Muntiacus muntajak*), hog deer (*A. porcinus*), wild boar (*Sus scrofa*), Indian hare (*Lepus nigricollis*), Small Indian civet (*Viverricula indica*), sloth bear (*Melursus ursinus*), yellow throated martin (*Martes flavigula*), Indian grey mongoose (*Herpestes edwardsi*) and jungle cat (*Felis chaus*). Each sign of wildlife presence and human disturbance was given a weight based on the rarity of the species and perceived magnitude of the disturbance (Tables 1 and 2; and Pictures 2 and 3).

All weighted values of animal presence and disturbances were summed up separately. Distances of each sample plot (inbetween the middle of the two sample plots) from the National Park border and nearest edge of the forest along the farm land were measured in a geographic information system (GIS) domain. Each plot was categorized into one of four groups based on its distance from the

Picture 1. Aerial photograph of the study area.

Table 1. Weightage given to the signs of the animals recorded in the Barandabhar Forest.

Animals recorded	Weighted values
Rhino	10
Tiger	10
Leopard	8
Sambar	6
Spotted deer	7
Barking deer	5
Hog deer	3
Wild boar	5
Indian hare	3
Civet	3
Sloth beer	8
Martin	4
Mangoose	2
Jungle cat	5

Table 2. Weightage given to the signs of the disturbances recorded in the Barandabhar Forest.

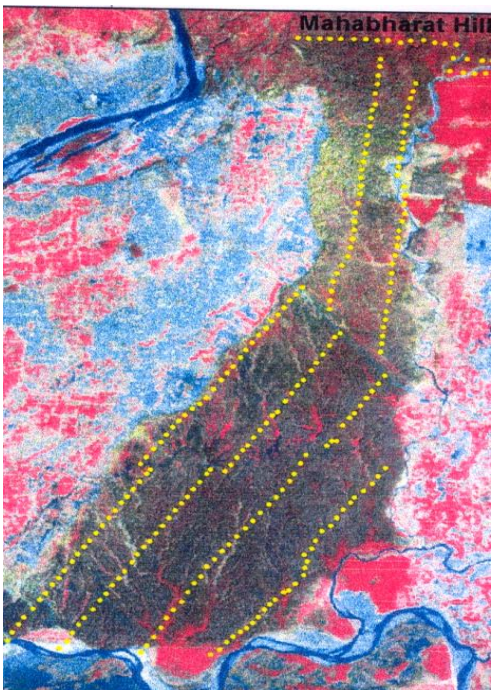
Signs of disturbances	Weighted values
Presence of cattle	5
Grass cutting	5
Thatch collection	5
Lopping signs	7
Human trails	6
Wood cutting	8
Debarking	7
Cart trail	10

National Park (in 4-km distance groups). The categories were created based on the intensity of disturbances due considering the distance from the core habitat area for the animals and from the farmland. One-way ANOVA followed by Tukey's honestly significant difference and analysis of covarience (Sokal and Rolph, 1995) were applied to understand the effect of increasing distance from National Park on wildlife use of the corridor (fixed effects) and increasing distance from the edge of the corridor (covariate) using SPSS (1999) software. The Ancova repeats the results of the one-way Anova for the distance categories and is unnecessary (ok).

RESULTS

Use of Barandabhar forest corridor by rhinoceros and other animals

Signs of sloth bear, leopard, tiger, rhinoceros and five species of ungulates were recorded in the Barandabhar forest (Figure 1). Spotted deer and wild boar signs were seen most commonly in plots. Large carnivore signs were rare but were clearly observed while rhinoceros signs were fairly common. The most abundant disturbance signs were in the form of livestock grazing and grass cutting for thatch and fodder (Figure 2). The occurrence



Picture 2. Sample plots along the transects in the study area.

Picture 3. Researcher showing the transect marking in the study area.

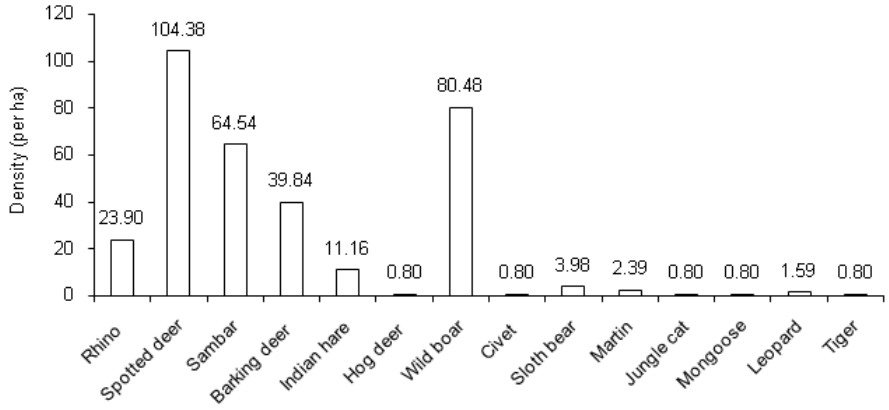


Figure 1. Density of wildlife signs in Barandabhar Forest corridor (per ha).

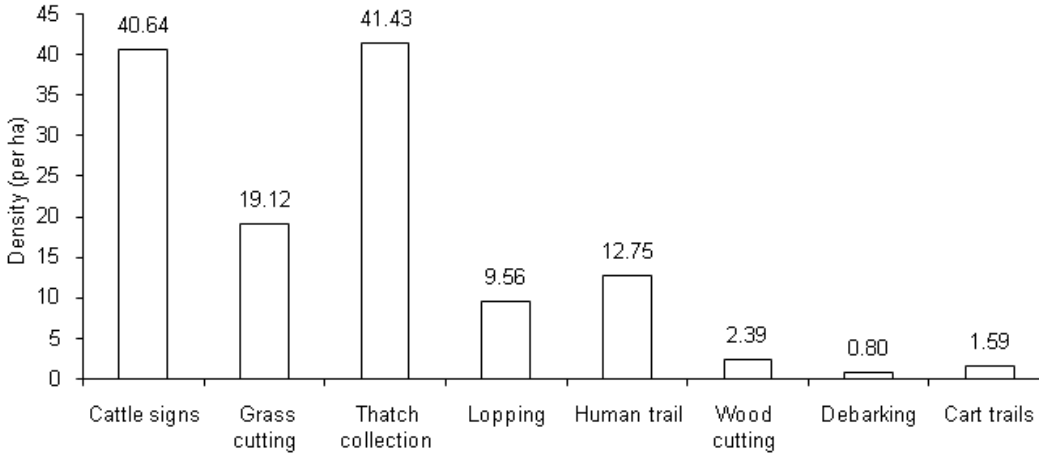


Figure 2. Density of disturbances in Barandabhar Forest corridor (per ha).

of wildlife signs were different between the four different distance categories ($F = 30.277$; $df = 3, 247$; $P \leq 0.001$). A post hoc Turkey's honestly significant test showed that wildlife signs from 0 to 12 km from the National Park boundary were similar, while wildlife signs between 13 to 16 km distances from National Park were lower than the first group (Tukey's test $P \leq 0.001$). The signs of disturbance were also different between different distance categories ($F = 3.59$; $df = 3, 247$; $P \leq 0.014$). The post hoc Turkey's test showed that the level of disturbance is significant in the area of third category (mid section of the corridor) at 12 km distance from the National Park boundary. The results of the analysis of covariance for the wildlife sign index and disturbance index as the dependent variables, distance from National Park in 4 categories as fixed effect and distance from the nearest edge of the corridor showed that wildlife signs decreased with distance from National Park, while disturbance was maximum in the middle part of the corridor (it was less near the National Park and near the Mahabharat foothill forests).

The covariate (distance from the nearest edge) was not significant for either wildlife signs or disturbance index suggesting that the corridor was too narrow to have a

Picture 4. Habitat used by wild and domestic animals in the Baradabhar Forest.

core of less disturbed area with more wildlife usage.

DISCUSSION

Function of Barandabhar forest as a wildlife corridor

At one time, the Tarai forests were connected to the Himalayan foothill forests and reported to be used by wildlife to move freely between these different ecological systems in this forest to exploit seasonal food resources and exchange genetic material (Patridge, 1978). The role of a corridor is vital to allow outward dispersal of individuals from a source population, reduce local concentrations and overcome environmental stochasticity (Noss, 1987). It also allows ecological separation and resource partitioning between different animal species. Most wildlife corridors have lost their effectiveness as a result of biotic pressures and developmental activities (Dendy, 1987). Corridors allow access to refuges and sources of recolonization in the event of floods, fire or diseases. Neglected corridors may detract from the value of wildlife use and increase the interface between animals and humans (Johnsingh et al., 1990). Corridors provide both temporary and permanent habitat for the animals. Moreover, the forest in these areas is essential to reduce habitat fragmentation (Dendy, 1987). The status of wildlife populations likely to be vulnerable to sporadic diseases, flood and resource crunch could be ensured by migration to alternative habitats. In the case of Chitwan, the foothills of Mahabharat range linked by the Baradabhar forest corridor could provide an alternative habitat in contrast to the view of Yonjan (1996). Periodic floods occurring in the Rapti flood plain forces rhinoceros towards the highlands of the Baradabhar forest corridor (Kandel and Upadhyay, 2010, Picture 4).

Gee (1959) has emphasized the importance of the inclusion of present study area and at least southern portion of it in the current CNP area. But at the time of establishment of CNP, policy makers and other concerned people might not have been conscious of the importance of Barandabhar forest as a corridor for the wildlife, although it was previously designated as Mahendra Mrig Kunja in 1959, covering parts of Barandabhar forest areas. The idea of using habitat corridors for elephant movements was introduced first in Sri Lanka in 1959 (Anon, 1959). Ironically, developmental projects like east-west national highway, irrigation canal, and other east-west crossing roads have fragmented wildlife habitats, though the concept of corridor was being developed elsewhere during that time. Yes it is related to the case of Sri Lanka.

Though, there were plenty of wildlife signs recorded during this study, the use of the corridor was likely to be higher during the monsoon as also reported by Gee (1959, 1963)? (No, it was studied during winter). This fact was highlighted by interviews of local people living on the fringes who stressed that rhinos intensively use the

corridor once more water becomes available and the flood plains of Rapti river are waterlogged (Dinerstein, 1991). This alternative habitat could be of critical use for rhinoceros (Kandel and Jhala, 2008) and one should never underestimate its importance by only considering the overall habitat preference throughout the year (Kandel and Jhala, 2008). Rhinoceros have different habitat preferences for different activities (Kandel and Upadhyay, 2010) and require a landscape that has a mosaic of different habitats to meet all their various requirements. The result of one-way ANOVA shows that the amount of wildlife signs is high up to 12 km from the National Park border and the level of disturbance is low. The habitat mid way in the corridor to Mahabharat Mountain beyond the East-West National Highway had the highest disturbance index and is under the most severe human pressure. It is the weakest link in the corridor due to the township of Bharatpur on one side and the recently rehabilitated village of Padampur (which had been previously enclaved in the CNP) on the other side.

If these pressures continue to increase unchecked then the impact would be severed and could no longer be used by wildlife. Floods occur almost every year compelling the rhinoceros and other animals to take refuge in the nearby Barandabhar forest. It is conceivable that heavy flooding in a single season or within a short span of years) could kill many animals by washing them away (Kandel, 2003). This corridor forest area offers a refuge for the species like rhinoceros and deer that depend on the grasslands. An average daily traffic of over 5082 vehicles has been recorded on the East-West National Highway (bus/truck: 2262, car/jeep/tractor: 551, motorbikes: 1040, micro/mini bus: 600, autorikshaw: 64, cycles: 535, rickshaw: 20, bullock cart: 10 per day) (Kandel, 2003). It is apparent that the absences of understorey cover as well as ground cover mainly along the highway is a serious impediment for animal movements. Animals have been reported to be killed while crossing the highway. Likewise the chances of migrating animals being exposed to poachers are very high. If entire stretch of the corridor can not be preserved intact, the animals may soon be left with no refuge in the Barandabhar Forest. Forest above the East-west Highway should gradually be conserved to maintain a corridor (Poudel et al., 1998). It is critical to conserve the potential and alternative habitats of corridors for endangered animals like rhinoceros and tigers according to the higher protection status as of other areas. Implementation of the proposed management plan and regular co-ordination and communication between agencies such as local governments, conservation-based organizations and other close stakeholders could lead to better prospects for the larger mammals that depend on humans to ensure their survival. There needs to be political will and sustainable participation of the local communities (Sharma, 1989). This should be achieved through establishing alternatives for fuel wood and fodder to support the livelihoods of people inhabiting the area. Strict enforcement practices through community-based planning should also be implemented. A committee comprising social workers, local community representatives, local administration and political units, Forest Department and the park authority should be formed and given full responsibility for managing the forest corridor immediately. Such an approach has been extremely successful in managing the buffer zone of Chitwan which consists primarily of community owned forestlands (Sharma, 1989). I also suggest the implementation of strict control over vehicle movement on the highway and to construct an overhead bridge in the long term. Similarly, grassland sites and water holes at uniform distances should be maintained for use by rhinoceros during seasonal movements. Otherwise the meta-populations of endangered animals like rhinoceros and tiger would be threatened.

Management of short grasslands for productivity (Kandel and Jhala, 2010) and reducing livestock pressure (Kandel, 2003) in the Baradabhar forest is very important. Intermittent intensive studies in Barandabhar forest corridor could be very useful to understand the seasonal patterns? of tropical ecosystems (Kandel and Jhala, 2008) and to update and augment the baseline that would help to inform better management in the future.

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