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# MANAGEMENT

## Observations on habitat preference of translocated rhinos in Bardia National Park and Suklaphanta Wildlife Reserve, Nepal

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### Abstract

Chitwan National Park had the only surviving greater one-horned rhino population in Nepal until the 1980s. To reduce the threat of losing this population to natural calamities, catastrophic events and poaching, rhinos were translocated to the Bardia National Park (BNP) and the Suklaphanta Wildlife Reserve (SWR). Translocations have thus been used as an active and successful management tool for rhinos in Nepal. As a follow up to these translocations, it was important to assess habitat use and the distribution pattern of rhinos in the new habitats. Monitoring was conducted in the Karnali floodplain of the BNP and in the core area of the SWR. Monitoring was based on direct observation and surveys of rhino signs (dung, track etc.). In BNP, rhinos were found to use grassland habitat, particularly in the floodplain areas. In the SWR, rhinos were found using the habitats between two river systems, which were comprised mainly of grassland, intermixed with wetlands and riverine forests. Breeding and an increase in the population show that the habitats in their former range (BNP and SWR) are still suitable for rhinos.

**Key words:** Rhinos, Translocation, Habitat, Floodplain, Nepal

### Résumé

Le Parc National Chitwan avait la seule population du Grand rhinocéros unicorne qui survivait au Népal jusque dans les années 1980. Pour réduire la menace de perdre cette population aux calamités naturelles, aux catastrophes et au braconnage, les rhinocéros étaient transférés au Parc National de Bardia (BNP) et dans la Réserve de la Faune de Suklaphanta (SWR). Les translocations ont donc été utilisées en tant qu'outil de gestion active et réussie pour les rhinocéros au Népal. Afin de suivre ces translocations, c'était important d'analyser l'usage de l'habitat et la répartition des rhinocéros dans les nouveaux habitats. On a donc fait un suivi dans le lit majeur de Karnali du Parc National de Bardia et dans une zone au cœur de la Réserve de la Faune de Suklaphanta. Le suivi était basé sur l'observation directe et l'étude des traces (les excréments, les empreintes de sabot) de rhinocéros. Dans le Parc National de Bardia, on a trouvé que les rhinocéros utilisaient l'habitat des herbages, en particulier dans les plaines inondables. Dans la Réserve de la Faune de Suklaphanta, on a trouvé que les rhinocéros utilisaient les habitats entre les deux systèmes de rivière qui comprenaient principalement des herbages, entremêlés avec les marécages et les forêts riveraines. La reproduction et l'accroissement de la population montrent que ces habitats (BNP et SWR) conviennent toujours aux rhinocéros.

## Introduction

The greater one-horned rhinoceros (*Rhinoceros unicornis*) is found only in South Asia. Historically, the rhinos were distributed in the floodplains and forest tracts of the Brahmaputra, the Ganges and the Indus river valleys. Today, however, no more than 2000 individuals remain in the wild, and these are distributed in a limited range within the Terai, at the foothill grasslands of the Eastern Himalayas and the Brahmaputra valley. This species, though numerous when compared to the other Asian rhino species, is still highly vulnerable. There are only two populations comprising more than 100 individuals each in the Kaziranga National Park in Assam, India, and the CNP in Nepal.

Since the first translocation of 13 rhinos in 1986 to BNP, a total of 87 rhinos—83 to BNP and 4 to SWR—have been translocated in seven translocation events over a period of 17 years (1986–2003).

Rhinos were released in two river floodplain areas of the BNP—the Babai and Karnali River floodplains, which are geographically separated by the Churia foothills and human settlements, making it virtually impossible for these two rhino sub-populations to intermix. So far, no movement of rhinos has been recorded from the Babai River floodplain into the Karnali River floodplain areas or vice versa.

The present study was conducted in the Karnali floodplain in the southeast of BNP and in the core area of SWR with the objective of assessing the habitat use and distribution patterns of translocated rhinos. The study was carried out over a period of two years between 2003 and 2005.

## Study Area

### Terai Arc Landscape

The Terai Arc Landscape stretches from Nepal's Bagmati River in the east to India's Yamuna River in the west. The landscape covers a network of protected areas, forest, agricultural lands, human settlements (rural and urban areas) and water bodies. It links 11 protected areas, from Parsa Wildlife Reserve

in Nepal to Rajaji National Park in India. On the Nepal side, 11,143 sq km of forest reserve links four protected areas: the Parsa Wildlife Reserve, CNP, BNP and SWR. The present study was carried out in BNP and SWR (Fig. 1) between 2003 and 2005.

### Bardia National Park

BNP (28°17'–28°40' N; 81°12'–81°42' E) is located in the southwest of Nepal and is the largest protected area in the Terai. It occupies an area of 968 km<sup>2</sup>, ranging from an altitude of 152–1441 m. Two major rivers, the Karnali and the Babai, flow through the national park (Fig. 2) and provide floodplain habitat for rhinos. Seventy rhinos were released in the Babai floodplain while 13 rhinos were released in the Karnali floodplain.

Translocated rhinos in the Babai River floodplain were monitored in April 2003 but due to growing insurgency, monitoring was abandoned there in 2004. Most of the anti-poaching posts were abandoned. The protection units merged to form units with more personnel for security reasons and stopped carrying out anti-poaching duties in the Babai Valley. In May 2006, however, a reconnaissance survey was carried out in the Babai River floodplain which revealed an alarming decline in the rhino population in the valley. Poaching was suspected to be the main cause of this decline. Subsequent surveys in 2007 and 2008 have confirmed the complete disappearance of rhinos from Babai valley.

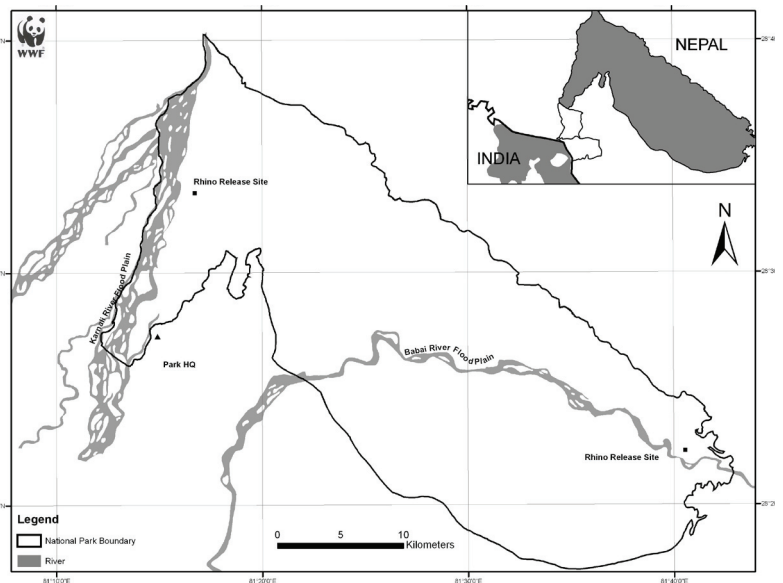


Figure 2. Bardia National Park.

In the Karnali River floodplain on the southwest boundary of BNP, the most recent monitoring was conducted in 2004 and 2005.

### *Suklaphanta Wildlife Reserve*

Suklaphanta Wildlife Reserve (28°45'–29°03'N; 80°05'–80°23'E) lies in the southwestern region of Nepal and covers an area of 305 sq km. Within this area is the 54 sq km Suklaphanta grassland—the largest patch of grassland in Nepal. Four rhinos were released into the southeastern part of the reserve's core area. The monitoring was conducted in the 155 km<sup>2</sup> core area of the reserve (Fig. 3).

## Methods

### *Bardia National Park*

We used two approaches to monitor rhinos in the Karnali floodplain. The first method consisted of reconnaissance using existing roads and tracks, from a vehicle or on foot, with rhino positions noted based on secondary evidence (like dung and tracks) or by direct sighting. In the second method we divided the Karnali floodplain area into upper and lower zones for logistic reasons (based on preliminary assessments and the logistics of getting around) and three monitoring routes (forest roads or elephant trails) were established within each of these two zones. Each zone was searched for the presence of rhinos from elephant-back. We surveyed these zones three times a week between September 2004 and June 2005.

Rhino signs (dung, track etc.) were recorded as fresh or old, the location geo-referenced (using a GPS) and a note made regarding the associated vegetation. This was then defined as habitat used by the rhino on that sampling occasion. When fresh signs were located, we tracked these until the rhino was sighted. We then took GPS locations and recorded habitat information *sal* (*Shorea robusta*) forest, riverine forest etc. In addition, we photographed the rhinos that were encountered during the survey period. We identified the rhinos based on characteristics such as their horn size, peculiarities or deformities found on their

body etc., following the guidelines set by Dinerstein (2003). We spent four man-hours each day and all the data were collected between 0600 to 1200 h.

### *Suklaphanta Wildlife Reserve*

Since the area to be covered was large, two monitoring teams (of two to three persons each) monitored the eastern and western parts of the reserve simultaneously. In the reserve, two major perennial rivers, the Chaudhar and Mahakali Rivers, flow across the eastern and western parts respectively, thus creating floodplain habitat for rhinos. Each of the seven rhinos could be identified easily based on their individual physical characteristics such as colour of radio collar or horn size. When a rhino was encountered, the teams recorded the GPS location and habitat type, behaviour, time, sex and age group. We used similar methods to those employed in BNP when collecting data on habitat use from rhino signs.

We conducted the survey in the period between September and June comprising three distinct seasons: monsoon (June–September), winter (October–February) and the dry season (March–May). The climate in both areas is the subtropical, monsoonal type. More than 80% of the precipitation occurs during the monsoon. Average temperatures reach up to 40°C between March and early June (the dry season) and gradually drops to about 5°C during November to January (winter).

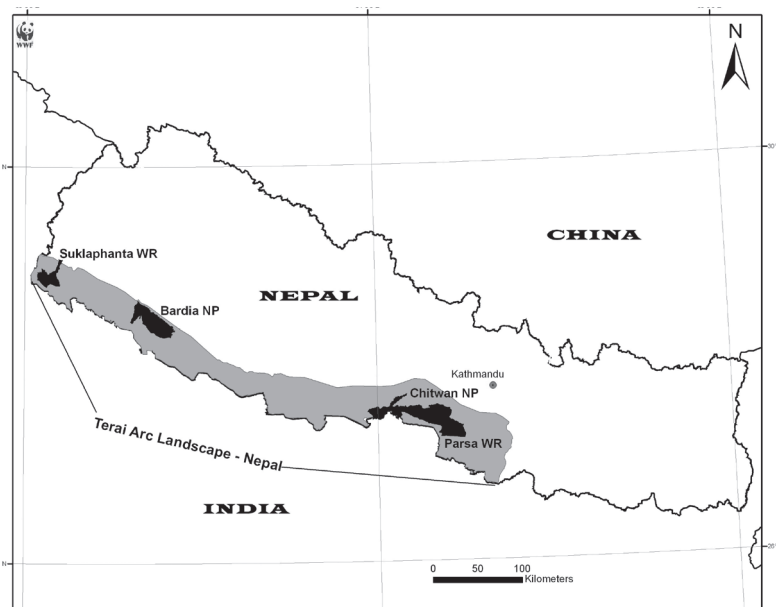


Figure 1. Terai Arc Landscape.

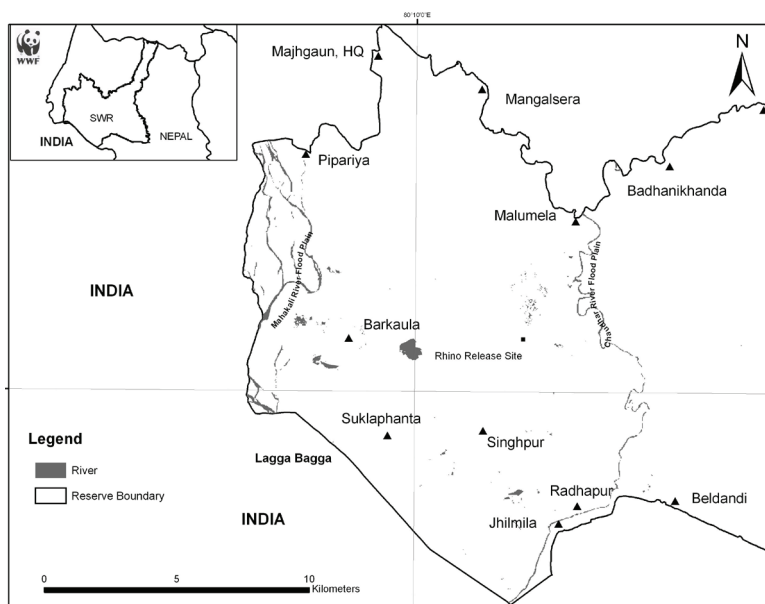


Figure 3. Suklaphanta Wildlife Reserve.

A floodplain is flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It includes the floodway, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. Most of the tall grassland falls within the floodplains of the Karnali and Babai Rivers in BNP, and the Mahakali and Chaudhar Rivers in SWR. Annual flooding rejuvenates most of the floodplain grasslands in the study area.

### Habitat Preference

To determine relative habitat preference of the translocated rhinos, the habitats were classified as grassland, riverine forest, *sal* forest, wetlands and other. The percentage of time spent searching for rhinos and the percentage of rhinos encountered were used to estimate habitat preference. Jacobs' preference index (Jacobs 1974) was calculated for the different habitat types. Values of the index range from -1 to +1 indicating avoidance and preference respectively.

The grassland habitat typically comprises three types of grasslands: (i) tall (ii) *phanta* (natural vegetation growing on previously cultivated dry fields) and (iii) wooded grassland with scattered tree species, also assumed to have an anthropogenic origin (Jnawali, 1995).

Table 1. Number of rhino observations according to habitat and search effort

| Habitat type    | Search effort in hrs (%) | Number of locations |          |                  |           | Total locations (%) |
|-----------------|--------------------------|---------------------|----------|------------------|-----------|---------------------|
|                 |                          | Male                | Female   | Female with calf | Unknown   |                     |
| Grassland       | 205(36)                  | 13                  | 2        | 14               | 15        | 44 (36)             |
| Riverine forest | 150(27)                  | 8                   | 1        | 11               | 12        | 32(26)              |
| Sal forest      | 10(2)                    | 0                   | 0        | 0                | 2         | 2(2)                |
| Wetland         | 189(34)                  | 1                   | 0        | 4                | 34        | 39(32)              |
| Others          | 5(1)                     | 0                   | 0        | 1                | 3         | 4(3)                |
| <b>Total</b>    | <b>559</b>               | <b>22</b>           | <b>3</b> | <b>30</b>        | <b>66</b> | <b>121</b>          |

## Results and Discussion

### Bardia National Park

A total of 559 hours of search effort yielded 107 locations of 25 rhinos in different habitats of the Karnali floodplain. A total of 63 locations were recorded based on direct observation while the remaining 44 locations were of indirect signs (rhino dung and track).

Spatially, rhinos were found to be distributed along the floodplain habitat of the Karnali River. Rhinos were mostly congregated in the floodplain grassland, riverine forest and wetlands (Table 1, Fig. 4). Floodplain grassland habitat mainly consists of floodplain grassland and wetlands (oxbow lakes/creeks). Thirty six per cent of locations were recorded in floodplain grassland whereas 32% of locations were recorded in wetland areas. The grasslands, riverine forest and oxbow lakes created and maintained by the periodic flooding of the Karnali River and its tributaries is a prime habitat for rhinos.

Seasonal variation in distribution of rhinos was recorded during the monitoring period. During the dry season the rhinos were mainly confined to the wetland and riverine habitats. During the winter season, rhinos were found to be raiding crops in the agricultural fields. Lack of forage could be a reason for the crop raiding observed during this season. Moreover, water levels are low during winter, thus creating opportunities for rhinos to raid crops across the Karnali River.

Table 2. Number of rhino observations with calculation of Jacobs habitat preference index

| Habitat type    | Search effort in hrs (%) | Total locations (%) | Jacobs index |
|-----------------|--------------------------|---------------------|--------------|
| Grassland       | 205(36)                  | 44 (36)             | 0.000        |
| Riverine Forest | 150(27)                  | 32(26)              | 0.001        |
| Sal Forest      | 10(2)                    | 2(2)                | 0.000        |
| Wetland         | 189(34)                  | 39(32)              | 0.001        |
| Others          | 5(1)                     | 4(3)                | -1.000       |
| Total           | 559                      | 121                 |              |

Grassland habitats exhibited the highest occupancy by rhinos. The Jacobs Index for habitat preference, however, shows no preference by the rhinos for any particular habitat (grassland, riverine forest or wetlands) within the Karnali River floodplain (Table 2). They spend most of their time in the floodplain ecosystem as noticed in Chitwan NP by Dinerstein (2003).

Rhino movements were also recorded outside the park boundary—in the 4 km stretch of riverine forest (corridor forest) connecting BNP with the Katarniaghat Wildlife Sanctuary (KWS) of India to the south. Distribution of rhinos in the corridor was seasonal. They

were recorded during winter and found to be raiding crops in the agricultural areas of the vicinity. However, these locations were not considered for calculating the preference index in Table 2, due to the low sample size (number of locations). Rhinos were found to be raiding wheat crops, prevalent mostly in winter and they were also found to be opportunistic raiders during other seasons such as the monsoon.

### Suklaphanta Wildlife Reserve

A total of 795 hours of search effort yielded 223 locations of seven rhinos in different habitats across the core area of the reserve (Table 3). A total of 126 locations was recorded based on direct observation of four translocated rhinos and three resident rhinos between October 2003 and June 2005. In addition to that, 97 locations of fresh dung-piles and spoors were also recorded in different habitats of the SWR.

Individual identified rhinos were recorded in all the habitat types of the reserve mainly in the stretch between the two river floodplains in the core area of the reserve. During the monitoring, rhino presence was recorded mostly in floodplain grassland (63%), but they also used the riverine forests and the wetlands to a lesser extent (Table 3).

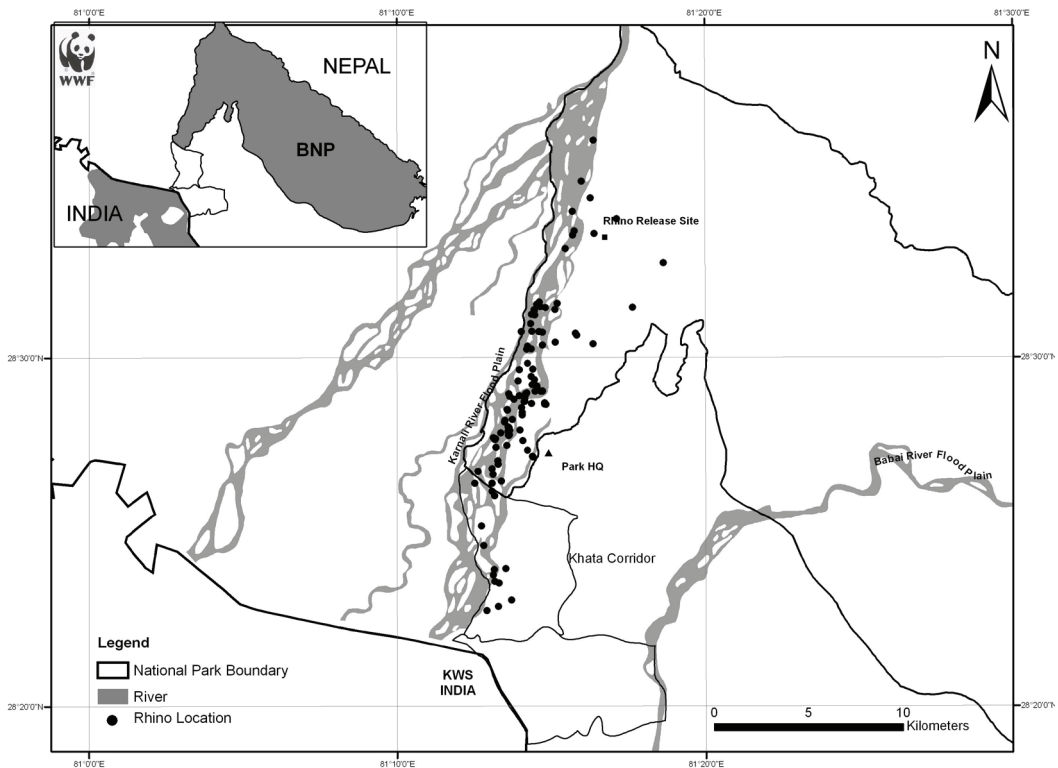


Figure 4. Rhino Distribution in BNP.



A spatial plot of rhino distribution shows that rhinos were found in habitats interspersed with grassland, wetlands and riverine forest in the eastern and western sections of the reserve (Fig. 5). The *sal* forest lying between the floodplains was found to be utilized only for ranging between these two habitat zones. During the dry season, rhinos were recorded in places near the floodplain habitat with adequate swampy wetland areas for wallowing. Hence, overall spatial distribution shows clustering in the grassland and wetland areas.

The Jacobs index showed no strong preference or avoidance regarding any of the major habitat types although rhinos predominantly used the floodplain habitats (grasslands, riverine forests and wetlands) as also observed in the Chitwan NP (Dinerstein, 2003; Table 4). These areas provide a good habitat for rhinos due to adequate grasslands (for feeding), dense forest (for feeding and resting) and wetlands (for wallowing). Annual flooding in the two river systems creates floodplain grasslands suitable for rhinos in the core areas of the reserve (Yonzon et al. 2003).

Rhino presence was recorded in the extension or buffer areas of SWR indicating that the rhinos were not just confined to the core areas of SWR (Fig. 5). The habitat in the newly extended area comprises *sal* forest and grassland. Rhinos were recorded mainly in areas having waterholes interspersed with aquatic vegetation like *Phragmites karka* and rapidly emerging tall grasslands. Grasslands in the extension areas are rapidly becoming a good habitat for rhinos with tall grassland, waterholes and riverine and *sal* forest in the vicinity. Therefore the newly extended area, if managed well, could potentially improve the carrying capacity of SWR for rhinos.

Transboundary rhino movement from SWR to Lagga Bagga in India was also observed suggesting that individuals disperse into the riverine forest habitat of

Table 3: Number of rhino observations according to habitat and search effort

| Habitat type    | Search effort in hrs (%) | Total locations (%) |
|-----------------|--------------------------|---------------------|
| Grassland       | 550 (69)                 | 140 (63)            |
| Riverine forest | 85(11)                   | 29 (13)             |
| Sal forest      | 35(4)                    | 10 (4)              |
| Wetland         | 90(11)                   | 35 (16)             |
| Others          | 35(4)                    | 9 (4)               |
| Total           | 795                      | 223                 |

Table 4. Number of rhino observations with calculation of Jacobs habitat preference index

| Habitat type    | Number of locations |        |                  |         | Jacobs index |
|-----------------|---------------------|--------|------------------|---------|--------------|
|                 | Male                | Female | Female with calf | Unknown |              |
| Grassland       | 19                  | 17     | 44               | 60      | 0.001        |
| Riverine forest | 8                   | 11     | 3                | 7       | -0.009       |
| Sal forest      | 4                   | 1      | 2                | 3       | 0.015        |
| Wetland         | 6                   | 4      | 6                | 19      | -0.014       |
| Others          | 0                   | 0      | 1                | 8       | 0.015        |
| Total           | 37                  | 33     | 56               | 97      |              |

India called Lagga Bagga (Fig. 5), which is a 5.9 km<sup>2</sup> riverine forest that is part of the Barahi Range of the Pilibhit Forest Division of India. It is situated on the northern side of the Sharada River (the Indian name for Nepal’s Mahakali River). The Lagga Bagga Forest is dominated by tall grasslands, which are interspersed with *Acacia catechu*, *Dalbergia sisso* and *Bombax ceiba* trees. The reserve supports several large mammals including rhinos and deer species such as the spotted deer (*Axis axis*) and the swamp deer (*Cervus duvauceli*) coming from SWR. Rhinos were found dispersing southwest as far as 7 km from the Nepal-India border. It has been reported that rhinos occasionally cross the Sharada River (Johnsingh et al. 2004).

In conclusion, the distribution of rhinos showed that floodplain grassland is the prime habitat for rhinos in both BNP and SWR. Within the floodplain, rhinos seem to have no preference for any particular habitat. The foraging pattern (availability of forage, annual grassland burning) and spatial location of wetland (swampy) areas seem to be two factors determining the distribution of rhinos in the floodplain ecosystem.

We feel that both BNP and SWR are good rhino habitats and the surrounding areas offer potential to increase the number of rhinos in the long term. Habitat management like grassland management (annual grassland burning) in key floodplain grassland habitats needs to be addressed in a timely fashion to ensure availability of forage for rhinos. Restoration of key waterholes and other available wetlands is key to survival during the dry season.

Anti-poaching operations need to be strengthened for a conservation dependent species like rhinos. There is a dire need for strong patrolling across the transborder areas to safeguard their existence in the available habitat. More co-ordination and landscape planning, however, are required to ensure that rhino habitats are

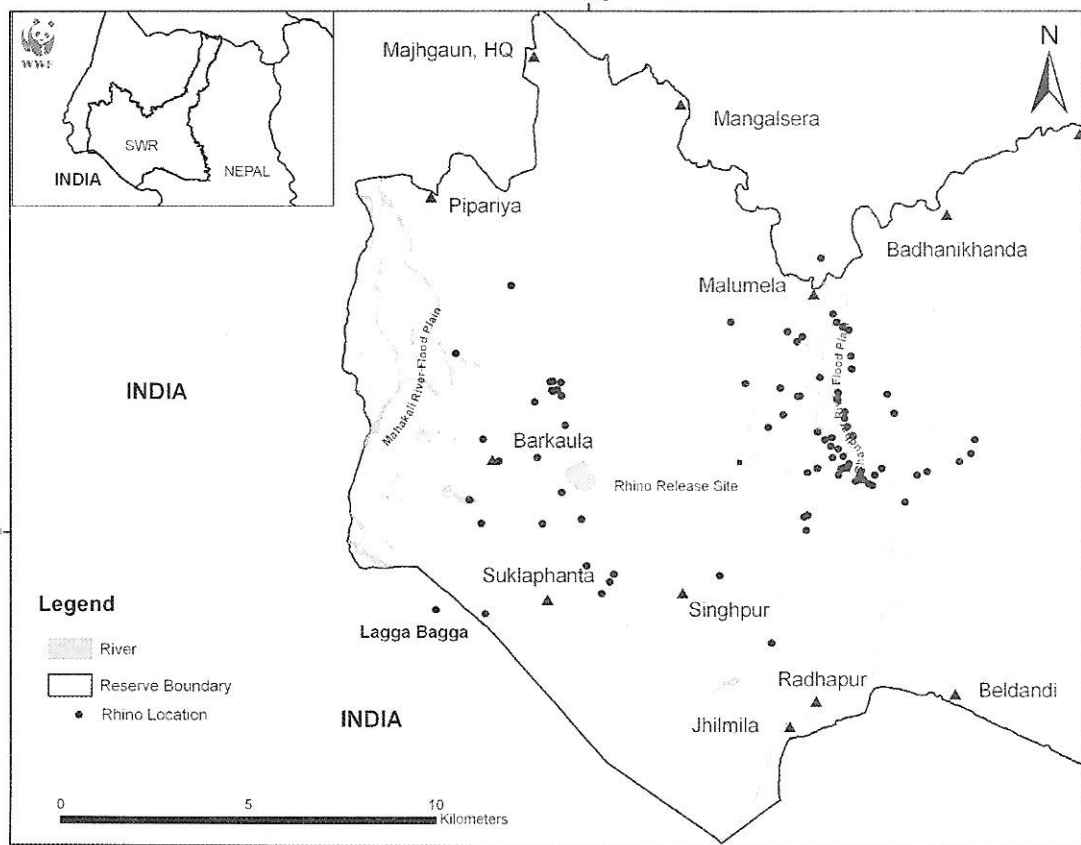


Figure 5. Rhino Distribution in SWR.

managed well on both sides of the India-Nepal border and adequate protection is afforded to dispersing rhinos on the Indian side of the Terai Arc landscape.

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