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A STUDY ON THE BEHAVIOR AND COLONIZATION OF TRANSLOCATED GREATER ONE-HORNED RHINOS *RHINOCEROS UNICORNIS* (MAMMALIA: PERISSODACTYLA: RHINOCEROTIDAE) DURING 90 DAYS FROM THEIR RELEASE AT MANAS NATIONAL PARK, ASSAM INDIA

OPEN ACCESS

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Abstract: Under the Indian Rhino Vision 2020, 18 wild Greater One-horned Rhinos *Rhinoceros unicornis* were translocated from two rhino bearing areas, Kaziranga National Park and Pobitora Wildlife Sanctuary to Manas National Park within the state of Assam, from 2008 to 2012. Following the release, the rhinos were closely monitored through radio tracking and direct observation to record their colonization pattern and behavioral adaptation to the new environment. Out of the 18 rhinos released at Manas, 16 (89%) rhinos dispersed in approximately the same direction from the release sites. The rhinos released from Pobitora Wildlife Sanctuary strayed more when compared to the rhinos from Kaziranga National Park. This paper describes the behavior patterns observed in Manas National Park, which may provide a useful alternative approach for future rhino translocation.

Keywords: Behavior, colonization, Greater One-horned Rhinoceros, Manas National Park, *Rhinoceros unicornis*, translocation.

সৰাংশঃ ইণ্ডিয়ান বাইন' ভিজন-২০২০ ৰ অন্তৰ্গত ১৮ টা বনৰীয়া এটা খড়গযুক্ত গড়, *Rhinoceros unicornis*, অসমৰ দুখন গড়ৰ অন্যতম বসতিস্থল কাজিৰঙা ৰাষ্ট্ৰীয় উদ্যান আৰু পৰিতৰা অভয়াৰণ্যৰ পৰা ক্ৰমে ২০০৮-২০১২ চনৰ ভিতৰত মানাহ ৰাষ্ট্ৰীয় উদ্যানলৈ স্থানান্তৰিত কৰা হৈছিল। মানাহৰ নতুন পৰিবেশত মুকলিমুৰীয়াৰূপে এৰি দিয়াৰ পাছত গড়ৰ বিচৰণ তথা অৱস্থিতি আৰু আচৰণ বেডিঅ ট্ৰেকিং আৰু প্ৰত্যক্ষভাৱে পৰ্যবেক্ষণ কৰা হৈছিল। মুক্তভাৱে এৰি দিয়া ১৮ টা গড়ৰ ভিতৰত ১৬ টা (৮৯%) গড় প্ৰায় একেটা দিশেৰে এৰি দিয়া স্থানৰ পৰা আঁতৰি গৈছিল। উল্লেখ্য যে, কাজিৰঙা ৰাষ্ট্ৰীয় উদ্যানৰ গড়তকৈ পৰিতৰা অভয়াৰণ্যৰ পৰা স্থানান্তৰিত কৰা গড়কেইটা সংৰক্ষিত বনাঞ্চলৰ পৰা বেছিকৈ বাহিৰলৈ ওলায় আহিছিল। এই গৱেষণাপত্ৰত, মানাহ ৰাষ্ট্ৰীয় উদ্যানত গড়ৰ আচৰণ সন্দৰ্ভত আলোচনা হৈছে আৰু ভৱিষ্যতৰ গড় স্থানান্তৰিত প্ৰক্ৰিয়াত এই আলোচিত বিষয় সমূহে প্ৰভুত বৰঙনি যোগাব বুলি আশা কৰা হৈছে।



Rhinoceros unicornis
Greater One-horned Rhinos



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INTRODUCTION

Translocation is the intentional release of an animal to the wild in an attempt to establish, reestablish or augment the population, (Griffaith et al. 1986). Rhino translocation for conservation purposes aims to further demographic and/or genetic rhino conservation goals and in so doing contribute to ensuring the long-term survival of rhino species and subspecies in viable populations in natural habitats throughout its historical range. Translocations may be undertaken to minimize the potential for loss of genetic diversity (Emslie et al. 2009).

Until the 1980s, six protected areas in Assam had breeding populations of Greater One-horned Rhinos (GOH) *Rhinoceros unicornis*. However, an armed insurgency problem, which led to a breakdown of law and order in Assam, resulted in the extermination of rhinos from Laokhowa Wildlife Sanctuary, Bura-Chapori Wildlife Sanctuary and Manas National Park (MNP) by the end of the 1990s leaving only three sites with rhinos (Dutta et al. 2012). Among the remaining populations of rhino in Nepal and India, only two sites had numbers in excess of 100 individuals, thus increasing the risk to the overall status of GoH (Foose & van Strien 1997).

The Department of Environment & Forests, Government of Assam clearly realized the dangers of having most of its rhinos at one site and thus was open to implementing a pro-active management strategy for rhinos in the state. The government of Assam, with support from International Rhino Foundation (IRF), World Wide Fund for Nature (WWF) and the United States Fish & Wildlife Service (USFWS), therefore, launched the Indian Rhino Vision (IRV) 2020 to help maintain existing rhino populations and to re-introduce rhinos into protected areas from which they were exterminated in the recent past. The program aimed at achieving a population of 3000 rhinos in Assam by the year 2020 spread over seven Protected Areas (Dutta et al. 2012). As a part of IRV 2020 program, 18 rhinos were translocated to MNP from Pobitora Wildlife Sanctuary (PWS) and Kaziranga National Park (KNP) from April 2008 to March 2012 (Sharma et al. 2012).

There were four rescued rhinos rehabilitated in MNP within a 600 acre solar electric fence enclosure (Fig. 1). Rhinos were rescued in KNP when they were about one to five months old during the flood season. The calves were hand reared and nursed at the Centre for Wildlife Rehabilitation and Conservation (CWRC) with the aim of releasing them to natural habitats. At the age of about three years the calves were translocated to MNP and

rehabilitated (Barman et al. 2014) (Table 1). We have observed an association of wild rhinos (R1 & R2) with these rehabilitated rhinos (Images 1 & 2).

The first three months post-release is the most critical for rhinos to settle down in a new habitat. It is strongly recommended that intensive post-release monitoring for 3–12 months should be undertaken immediately after release and during the settling-in phase (Emslie et al. 2009). However, the behavior of rhinos post release has never been intensively monitored on any translocation programme (Gottert et al. 2010). The primary goal of this study was to examine species specific exploration behavior and the colonization pattern of all 18 rhinos in their new home during the first three months following release, and its influence on park management.

Study Area

The study was carried out in Manas National Park, one of India's UNESCO World Heritage Sites in India. MNP is situated between 26°30'–27°00'N and 91°51'–92°00'E (Fig. 2). It is located in the foothill zone of Himalaya in the northern bank of Brahmaputra Valley and falls within the newly created districts of Chirang and Baksa along the international boundary between Indo-Bhutan and Assam, India. The biological richness of the Northern Bank Landscape (NBL) of the Brahmaputra has been recognized by WWF and it is one of the Global 200 eco-regions of importance (Olson et al. 2002). MNP is famous for its rich floral and faunal biodiversity including species such as Tiger *Panthera tigris tigris*, Pygmy Hog *Sus salvania*, Golden Langur *Trachypithecus geei*, Hispid Hare *Caprolagus hispidus*, Bengal Florican *Houbaropsis bengalensis* and White-winged Wood Duck *Cairina scutulata*. MNP has a good rhino habitat and had more than 100 rhinos until the mid-1990s (Lucy & Martin 1994).

The beginning of the management history dates back to 1905, when the area was declared as North Kamrup Reserved Forests, and later in 1928 the 361km²

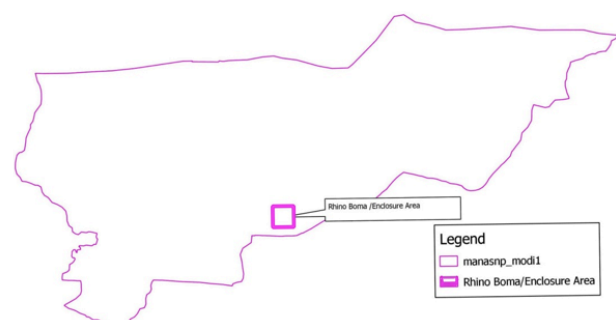


Figure 1. Showing sites of Rhino Boma/Enclosure Area

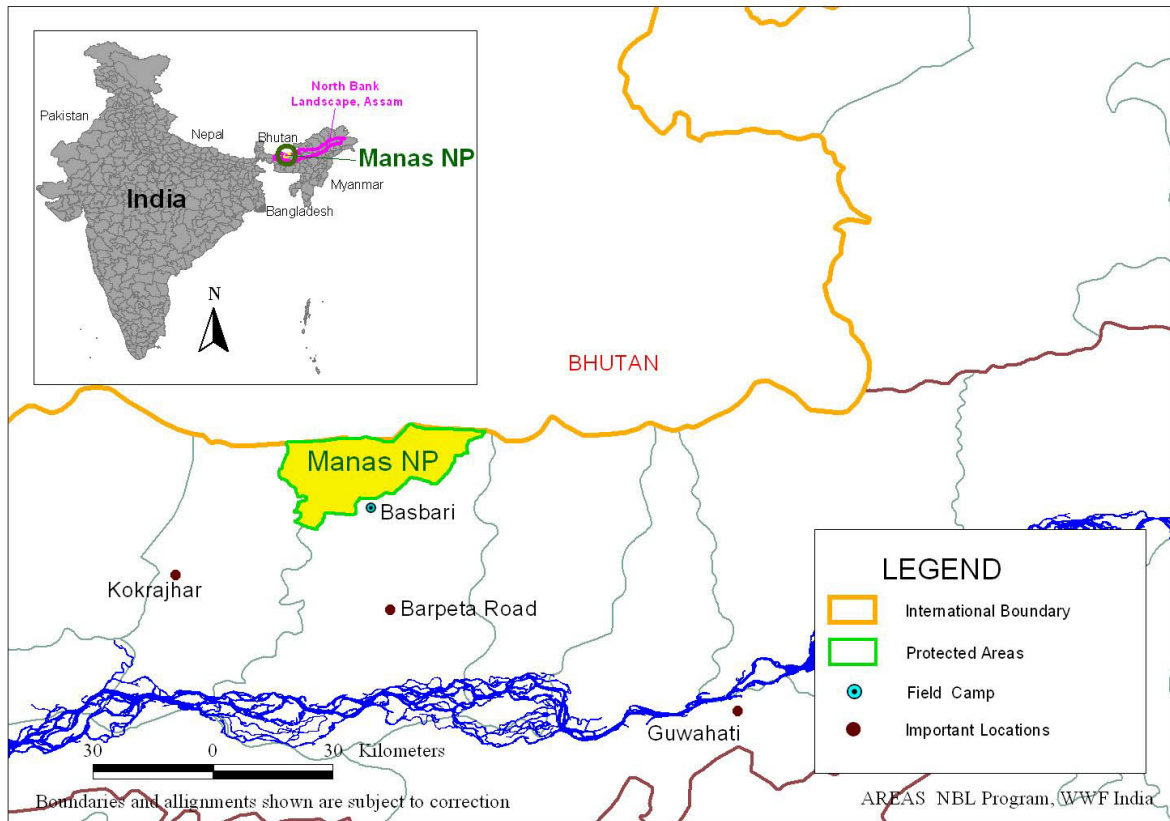


Figure 2. Manas National Park, Assam



Image 1. Rhino 1.



Image 2. Rhino 2 (Iragdao)

area was named as ‘Manas Game Sanctuary’. From 1951 to 1955, the area was increased to 391km². The Manas Tiger Reserve (2837km²) was included as one of the first eight tiger reserves declared in the country under Project Tiger in 1972. Within the sanctuary, 391km² was designated as a core area. The sanctuary area was also inscribed in the list of World Heritage Sites in 1985 because of its outstanding universal value.

Manas, a site of outstanding universal value, under the UNESCO Natural criteria: (vii), (ix) and (x). MNP has been evaluated to meet these outstanding values on the following basis:

(vii) The reserve contains superlative natural features of exceptional natural beauty in terms of its scenic attraction of forested hills, alluvial grassland and semi evergreen forests. (Image 3)

Table I. Details of Rescued rhino's translocation to Manas National Park (period, 2006–2008)

	Origin	Sex	Age	Name	Date of translocation	Remark
1	Kaziranga CWRC	F	3	Mainao	21.ii.2006	Presently in the wild and it has given birth (calf) on 2 June 2013
2	Kaziranga CWRC	F	3	Ganga	28.i.2007	Presently in the wild and it has given birth (calf) on 5 April 2013
3	Kaziranga CWRC	F	3	Jamuna	28.i.2007	Presently in the wild and it has given birth (calf) on 5 July 2013
4	Kaziranga CWRC	F	2		23.ii.2008	Died October, 2008

CWRC - Centre for Wildlife Rehabilitation and Conservation

(ix) The Manas River is an outstanding example of geological process and biological evolution with its huge depositional load and shifting river channels.

(x) Manas provides a critical and viable habitat for more rare and endangered species than any other of the Indian Subcontinent's protected areas. It is the only and best remaining natural area where sizable populations of several species can continue to survive (Guy & Lethier 2008).

The entire Manas Tiger Reserve was also declared a Biosphere Reserve in 1989. Manas finally was declared as a National Park in 1990, when it was enlarged to 519.00km² including the Manas Tiger Reserve (Fig. 2).

METHODS

Very High Frequency (VHF) radio collars (African Wildlife Tracking) were placed on rhinos prior to their release. Immediately after translocation, the rhinos were tracked and located at three times - daily morning, afternoon and evening (i.e., from 06.00–10.00 hr, 10.00–14.00 hr, and 14.00–18.00 hr). Sometimes rhinos were also located at night (i.e., 18:00–06.00 hr) which is largely dependent on accessibility factors. Tracking of the rhinos were carried out by using directional antennae on foot, elephant back, motorcycles or vehicles, depending on the area where the rhinos were present (Images 4–6). Focal observation was carried out using binoculars and spatial ancillary information was recorded with a handheld GPS unit (Garmin Inc.). The rhinos were translocated and released in six undertaken for the first three months post the release of each group of rhinos (Table 2).

Focal all occurrences behavior sampling (Altman

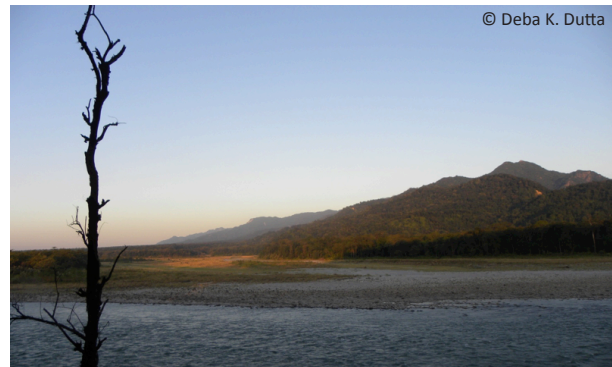


Image 3. Panoramic view of Manas National Park with river Manas



Image 4. Rhino monitoring team with Elephant



Image 5. Tracking rhinos from the top of the hill



Image 6. Rhino tracking from the top the vehicle by the researcher

Table 2. Details of rhino translocation to Manas National Park

	Name of the translocation/batches	No. of Rhino translocated /Sex	Rhino-code	Place of origin	Date of release
1	Training-cum-translocation	2 subadult males	Rhino 1, 2	Pobitora WS	12.iv.2008
2	2 nd phase of translocation	A cow and a female calf	Rhino 3, 4	Pobitora WS	28.xii.2010
3	3 rd phase of translocation	A cow and male calf, 1 adult male, 1 adult female	Rhino 5, 6, 7, 8	Pobitora WS	18.i.2011
4	4 th phase of translocation	2 adult females	Rhino 9, 10	Pobitora WS	9.i.2012
5	5 th phase of translocation	2 cows and 1 female calf and 1 male calf	Rhino 11, 12, 13, 14	Kaziranga NP	20.ii.2012
6	6 th phase of translocation	2cows and 2 male calves	Rhino 15, 16, 17, 18	Kaziranga NP	12.iii.2012

Table 3. Ethogram with description of behavior

Types of behavior	Description
Feeding	Approach grasses and take in to mouth
Wallowing	Almost all parts of body dipped into mud and water
Resting	Animal is resting position (lying and sitting) in inactive and relaxed
Walking	Animal moving attentively

1974) was conducted whenever a direct observation was possible. In the focal sampling all occurrences of specified actions of one individual were recorded during a predetermined sample of one hour. All occurrences sampling- as per this method we focused on a particular behavior rather than a particular animal. Behavioral categories were broadly defined as feeding, wallowing, walking and resting (Table 3). We have also recorded association pattern with other translocated rhinos and rescued, hand reared rhinos. Animals found in close proximity (within 10m) were recorded as an association (Patton et al. 2012). The rhino's stray occurrences also were recorded during this period. All data were entered in Microsoft excel software. The colonization pattern of each group was analyzed with one way analysis of variance (single factor ANOVA). Chi-square goodness of fit test was performed to find out if there were any significant stray occurrences and behavioral aspects among the rhino groups.

RESULTS

The results are based on our primary observation and tracking of rhinos. All rhinos were released in a release site at Buraburijhar of Bansbari range (Fig. 3) except the adult female Rhino 8. Rhino 8 was found to be pregnant so veterinarians suggested a soft release at the rhino enclosure near the Rhino camp but she moved outside immediately after release at the enclosure (Fig. 4).

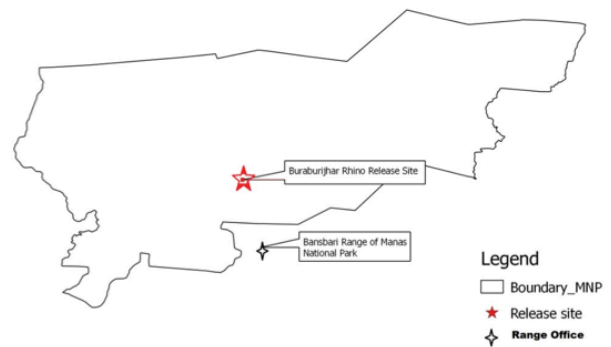


Figure 3. Buraburijhar Rhino release site

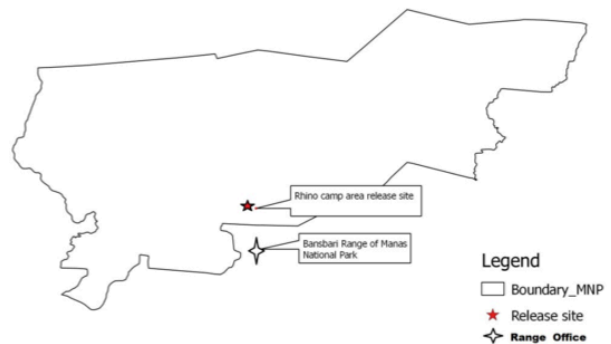


Figure 4. Rhino Camp area rhino release site

Distance Travelled from Release Site

After the release two individuals of the first group of translocated rhinos moved approximately 5km away from the release site (Sharma unpub. data). Groups of rhinos that were released subsequently moved an average of 3.1km from the release site. Out of the 18 rhinos released at Manas, 16 (89%) dispersed almost in the same direction towards the eastern bank of river Beki from the release site (Table 4). It was observed that all crates faced the northern direction so after release the rhinos directly reached Buraburijhar River which is situated just 100m away from the release site and

Table 4. Distance covered by rhinos between release sites just after the first day of release.

	Rhino code	Rhino sex	Rhino age	Release Date	Release site	Nearest Site	Distance km
1	R-1	M	10	12.iv.2008	Buraburijhar	Rhino camp	3.5
2	R-2	M	7	12.iv.2008	Buraburijhar	Charphuli	3.5
3	R-3	F	10	28.xii.2011	Buraburijhar	Langpati area	3.21
4	R-4	F (calf)	3	28.xii.2011	Buraburijhar	Second gate area	3.25
5	R-5	M	8	18.i.2011	Buraburijhar	Langpati area	3.21
6	R-6	F	10	18.i.2011	Buraburijhar	Langpati area	3.21
7	R-7	M (calf)	2	18.i.2011	Buraburijhar	Langpati area	3.21
8	R-8	F	9	18.i.2011	Rhino Camp	Panchmile area	2.31
9	R-9	F	8	9.i.2012	Buraburijhar	Buraburijhar area	0.5
10	R-10	F	10	9.i.2012	Buraburijhar	Buraburijhar area	0.5
11	R-11	F (calf)	2	20.ii.2012	Buraburijhar	Buraburijhar area	0.5
12	R-12	F	10	20.ii.2012	Buraburijhar	Buraburijhar area	0.5
13	R-13	F	10	20.ii.2012	Buraburijhar	Buraburijhar area	0.5
14	R-14	M (calf)	2 & ½	20.ii.2012	Buraburijhar	Dhodongbaha area	1.18
15	R-15	F	10	12.iii.2013	Buraburijhar	Charphuli	3.92
16	R-16	M (calf)	2	12.iii.2013	Buraburijhar	Charphuli	3.92
17	R-17	F	12	12.iii.2013	Buraburijhar	Charphuli	3.92
18	R18	M (calf)	3	12.iii.2013	Buraburijhar	Charphuli	3.92
							2.4 (Average)

through the river channel, all rhinos finally reached the eastern bank of River Beki.

Pattern of colonization after release at Manas NP

To observe some short terms of fluctuation pattern, we studied each rhino's movement at 10-day intervals. Similar studies have already been carried out by Patton and Cambell (2010) in Kenya for same day free release of Black Rhinos translocated.

In the first group, two sub adult male rhinos (R1 & R2) were released in MNP. During 90 days of observation period, these two rhinos were located 87% (n=273) of the time in Bansbari range and 13% (n=41) in Bhuyanpara range. There was no significance observed in their colonization pattern [F (20,32)=1.01, p=0.46], (Fig. 5).

In the second group, a pair - a mother (R3) (Image 7) and a female calf (R4) was released at Buraburijhar of Bansbari range. They were located 76% (n=193) of the time in the Bansbari range and 24% of the time (n=68) at Panbari areas. As per an analysis of data, there was a strong significance pattern of colonization observed in this group [F (12, 33)=4.1, p=0.006], (Fig. 6).

In the third group, one adult male (R5), a pair - comprising a cow and a calf (R6 & R7) and one adult female (R8) were released (Images 8–9). This group was

located 90% (n=557) of the time at Bansbari area and 10% (n=62) of the time at Bhuyanpara range and the pattern of colonization was insignificant for this group [F (17, 75) =3.8, p=2.8], (Fig. 7).

In the fourth group, two adult females (R9 & R10) were released. They were located 46% (n=142) of the time in Bansbari range and 56% (n=72) of the time in Bhuyanpara range and the pattern of colonization found significance [F (16, 59) =1.9, p=0.02], (Fig. 8).

In the fifth group, two pairs of cow and calf (R11 &12 and R13 &14) were released (Image 10). This group was located 87.90% (n=291) of the time at Bansbari and 12.10% (n=40) of the time at Bhuyanpara range and the pattern of colonization was insignificant [F (22, 49)=1.1, p=0.3], (Fig. 9).

In the sixth group, two pairs of cow and calf (R15, R16, R17 & 18) were released. This group was located 83% (n=285) of the time at Bansbari and 17% (n=44) of the time at Bhuyanpara range and the pattern of colonization was significant [F (23, 191)=1.7, p=0.02] (Fig. 10). As per the colonization pattern, it was found that Bansbari range was preferable for all rhino groups than the Bhuyanpara and Panbari ranges.

Behavior of Rhinos

In the first group (R1 & R2) consisting of two sub

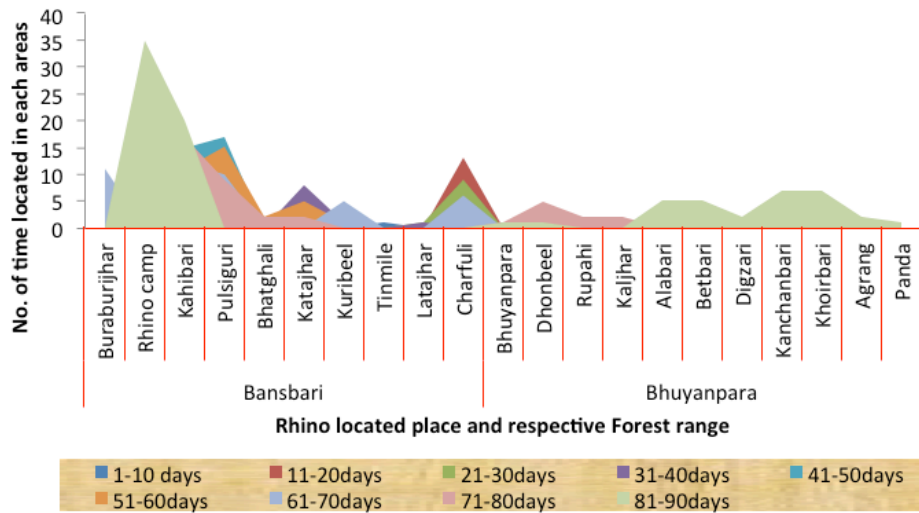


Figure 5. Colonization pattern of the 1st group of Rhino

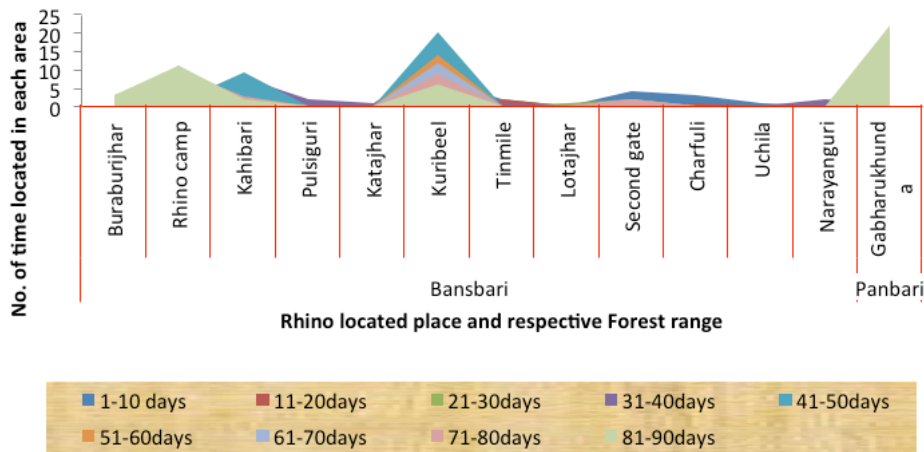


Figure 6. Colonization pattern of the 2nd group of rhino



Image 7. Rhino 3 (Laisiri).



Image 8. Rhino 6, 7 (Xavira and Syra).

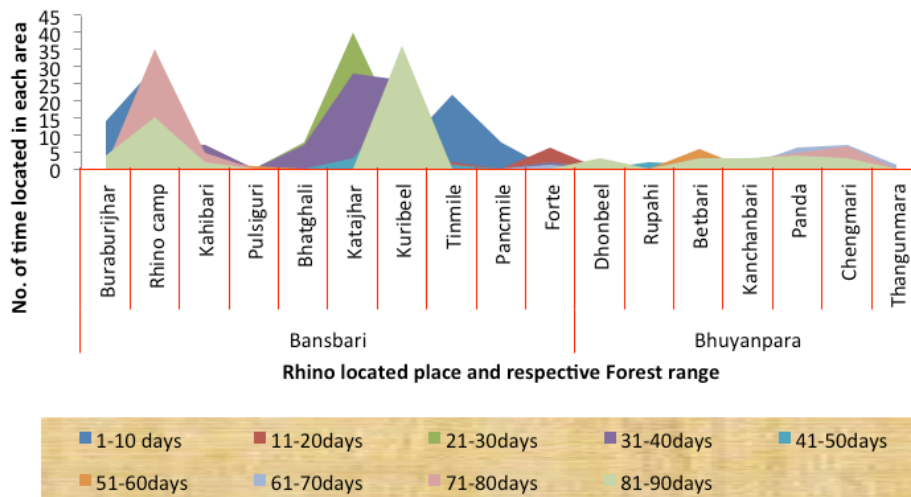


Figure 7. Colonization pattern of the 3rd group of rhino

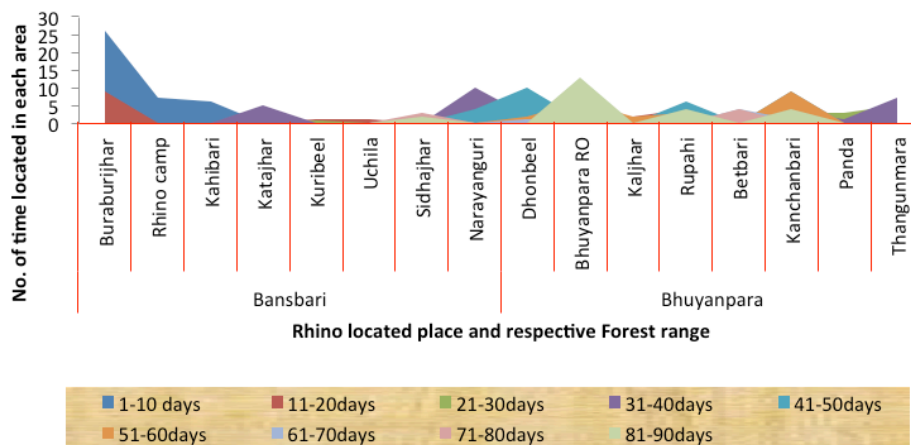


Figure 8. Colonization pattern of the 4th group of rhino



Image 9. Rhino 8 (Giribala).

adults, we were able to observe the animal in 72% of attempted observations (n=491). In the second group (R3 & R4) consisting of a pair of females (a cow and calf), we successfully observed the dyad 44% of attempted observations (n=309). In the third group (R5, R6, R7 & R8) consisting of one adult male, a cow and calf and one adult female we successfully observed the animal during 65% of attempted observations (out of a total effort of n=678). In the fourth group, which consisted of two adult females (R9 & R10), we successfully observed the animals in 44% of attempted observations (n=226). In the fifth group consisting of two cow-calf dyads, we successfully observed the animals on 35% of attempted observations (n=490). In the sixth group consisting of two cow-calf dyads, we successfully observed the animals only 20% of the attempted observations (n=462). This group was difficult to observe because

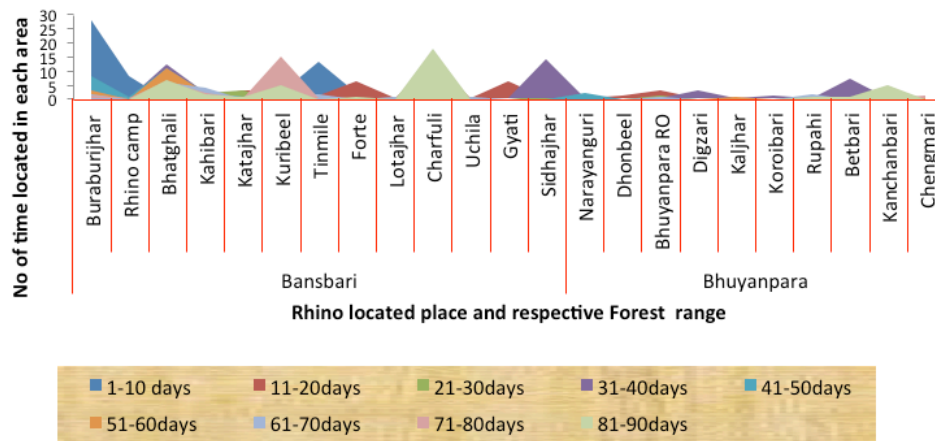


Figure 9. Colonization pattern of the 5th group of rhino

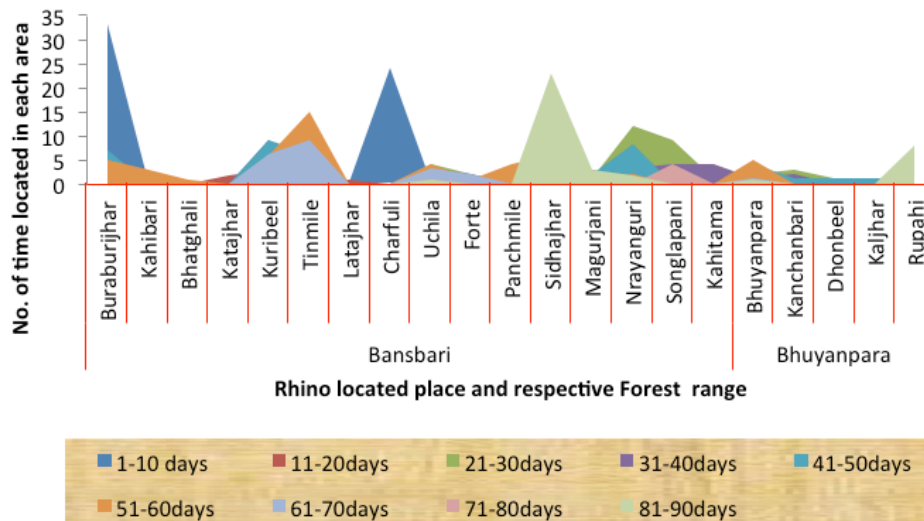


Figure 10. Colonization pattern of the 6th group of rhino

both pairs were using very difficult areas of Bansbari and Bhuyanpara range where it was not logistically possible to locate them every day.

There were six adult females (R3, R6, R12, R13, R15 & R17) with calves. Adult females (with calf) that were devoted 54% of the time in feeding, 13% of the time in wallowing, 28% of the time in walking and 5% of the time in resting. Similarly, we had three adult females without calves (R8, R9 and R10) that spent 51% of the time in feeding, 15% of the time in wallowing, 23% of the time in walking and 11% of the time in resting. Adult females with calves spent more time on feeding and walking as compared to females without calf. But there was no significant difference found between the Adult female rhinos with calf or without calf ($\chi^2=1.36$, $df=3$, NS). (Fig. 11).

We had three adult male rhinos (R1, R2, R5), and

they spent 47% of the time in feeding, 22% of the time in wallowing, 15% of the time on walking and 16% of the time in resting. Although it was found that adult females spent more time in feeding and walking as compared to adult male rhinos whereas adult males were found to spend more time on wallowing and resting. But there was no significant difference found between the adult male and adult female rhinos without calf ($\chi^2=5.28$, $df=3$, NS) or with calf (Fig. 12).

We had six calves and they devoted 48% of the time in feeding, 14% of the time in wallowing, 28% of the time in walking and only 10% of the time in resting. Both male and female calves got separated from their mother when any adult bull was in close proximity. So, they spent more time on walking and exploring new areas after their release. When we compared adult males, adult females and calves behavior we did not find any

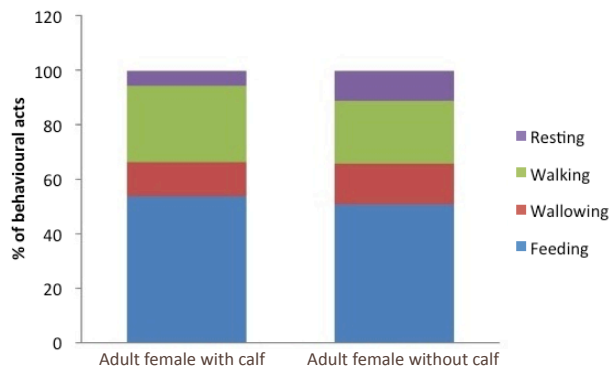


Figure 11. Adult female (with calf) and adult female (without calf) comparison of behavior

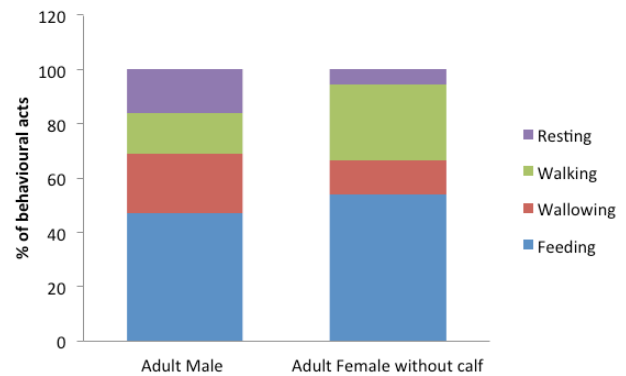


Figure 12. Adult male and adult female (without calf) comparison of behavior activity.

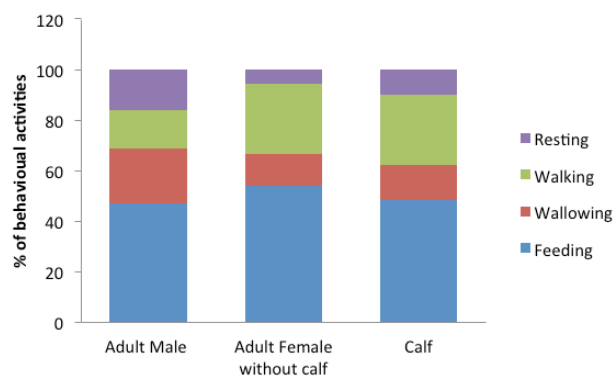


Figure 13. Behavior comparison of adult male, female and calves



Image 10. Release of Rhino 13, 14 at Manas NP

significant changes ($\chi^2=5.86$, $df = 6$, NS) (Fig. 13).

Rhinos were found feeding early in the morning and late in the afternoon. Wallowing was the prime activity during noon in shallow waterholes containing mud and water. In case of resting the rhinos preferred being inside wood land and bushy areas.

Straying of Rhinos

Just after their release in MNP, some rhinos wandered and entered fringe villages of the national park. A few individuals strayed outside to adjacent paddy fields. They fed on the crops and also damaged them by walking inside the cropping areas.

Rhino straying is a very common occurrence in Pobitora WS, the source for some of the translocated rhinos. About 25–30 % of rhinos living in Pobitora stray out from the core zone of the park to forage in the surrounding villages at night (Talukdar 1999). This might contribute to the rhinos released from PWS straying more frequently than those from KNP. Significantly, rhinos translocated from PWS (91.6%) had more straying occurrences than the rhinos from KNP (8.4%) ($\chi^2=35.19$,

$df=1$, $p<0.05$), (Fig. 14).

The first group of rhinos strayed several times ($n=67$). The second group strayed only once ($n=1$). The third group strayed nine times ($n=9$), the fourth group of rhinos strayed ten times ($n=10$) while the fifth and sixth groups strayed four times ($n=4$) each. Significantly, straying of the first group occurred more number of times than any other group ($\chi^2=202.07$, $df=5$, $p<0.05$) (Fig. 15).

Straying of the Greater One-horned Rhinos from protected areas to fringe villages is commonly observed mainly for reasons such as increased biotic pressure on protected habitats resulting in degradation of the habitat. Some of the rhinos in Pobitora are habituated with straying for crop raiding in fringe areas (Dutta et al. unpublished). It was assumed that the first group's two male rhinos might be habitual crop raiders so we found more stray incidents with them than later groups of rhinos released in MNP. Another fact was that the first group of rhinos liked to use grazing areas of

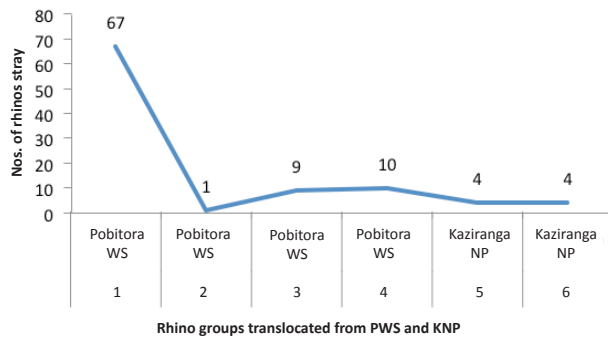


Figure 14. Pobitora Wildlife Sanctuary and Kaziranga National Park rhinos' stray occurrences after being released at Manas National Park

domesticated cattle and buffaloes near the southern boundary and eventually outside the park along with cattle and buffaloes in the evening.

Straying incidents occurred on an average of 15 days after release; and always occurred early in the evening or late at night. While straying, the rhinos tried to enter paddy fields, vegetable farms and orchards; they also raided crops and sometimes entered waterholes near tea gardens adjacent to the Bansbari range. Only seven of the 87 straying incidents occurred after midnight; the majority of straying incidents occurred from the hours of 17.00hr to 22.00hr for all the groups of rhinos. Sometimes, accidental separation of cows and calves led to straying. For example, cow 17 and her calf R18 became separated 15 days post-release, straying in two different directions. The separated cow and calf created chaos in a village 12km away from the MNP and in an attempt to reunite, one person was killed the next day. However, both the rhinos entered the park that same night and afterwards they only strayed in very close proximity of the park boundary where water holes were available. Rhino-3 also strayed outside once, near the Bansbari range entry point after she also was separated from her calf, 26 days after release.

DISCUSSION

This was the first wild to wild rhino translocation programme in the conservation history of Assam. This study is one of the first on colonization patterns and post-translocation behavior for Greater One-horned Rhinos. Observations confirmed that the Bansbari range was preferred by all the groups of rhinos after release at Manas. Twenty-eight days after release, the rhinos were seen moving to other two ranges (i.e., Panbari and Bhuyanpara) by crossing even big rivers like the Beki and

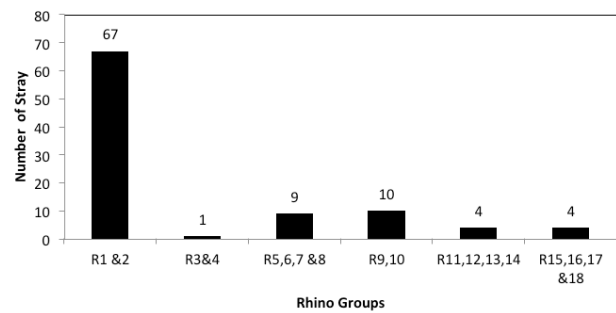


Figure 15. Group wise stray occurrences after being released at Manas National Park

Hakuwa. This indicates that even small rhino calves (2 years old) can swim across fast flowing rivers. During the first 25–30 days post-release, all the rhinos colonized different places within Bansbari; it was not until after this time that some rhinos went exploring the Panbari and Bhuyanpara ranges. Eight of the 18 rhinos used the central part of the Bansbari range; five rhinos moved to Bhuyanpara range; four rhinos moved to the western part of Bansbari and only one rhino reached the Panbari range crossing river Beki during the study period.

Before the release of the first group of rhinos in Manas, about 300kg of dry rhino dung was carried from PWS and was spread around the Buraburijhar. We did this so that the released rhinos become accustomed to dung middens, which we had hoped would prevent them from wandering too far after release. This seemed to reduce the movement of two rhinos (i.e., R1 & R2). As later groups of rhinos were released, it is possible that the gradual decrease of the first day's movement of each group might be because of the presence of previous groups of rhinos and the presence of five large dung heaps around the Buraburijhar areas and perennial water sources.

Although rhinos are not regarded as social animals, they appeared to demonstrate some affinity observed after release at the new site. The first two translocated sub-adult male rhinos remain solitary but strayed together after 40 days from release at new home. There was no sign of aggression observed between them. This is similar to what has been seen in other rhino species. Black Rhinos released in Mun-ya-Wana Game Reserve in Africa also showed no evidence of aggression or fighting during the first few days after release (Linklater et al. 2006). Similarly, no aggression was observed on the same day released translocated black rhinos in Kenya (Patton et al. 2010), according to Linklater & Swaisgood (2008), the death of black rhinos post-release was more closely related to recipient reserve size and release

density rather than the interaction of sex and age and the presence of resident conspecifics.

There were six cow-calf dyads among the translocated rhinos released in MNP. Among them, two cows had female calves and four had male calves. At release two crates were used for transporting so that the cow and calf could continue their bond. But, most likely because of confusion associated with being moved to a new site, almost all the dyads separated just after release. All the cows and calves reunited within 24 hours after release. But it was observed that the cows showed an affinity towards male calves whereas cows that had female calves had very loose bonding. A strong relationship between a cow and calf is vital as the cow would be aggressively protective of the calf in any new home land (Patton et al. 2010). Rhino 3 with her female calf (R4) was released simultaneously but they were separated just after release and reunited the same day evening. After 26 days, they were completely dissociated and the calf moved to the Panbari range by crossing the Beki River. A similar thing was also observed with adult cow R12 with her calf R11. Both of them dissociated just after 25 days from release. This could also be attributed to the fact that Rhino 2 (adult male) tried to overpower the female calves and they were scared and moved away to a safe distance. The female calf R11 was only two years old at the time of release. Twenty-four days post-release the dominant male R2 was trying to mount her at a swampy area in the evening. The sexually immature female calf got stuck in the deep mud and was unable to move. Fortunately, the rhino monitoring team got the noises of the female calf and chased the male rhino away with a search light and saved her life. After two days of instance, the calf moved to the Kahitama area by crossing the Beki River.

Significantly, an association of an adult cow with a male calf was very prominent. The adult cow R6 with male calf R7 used the same locations till the end of the study period. A similar behavior was also noticed in the other three adult cows and calves: R13 (cow) - R14 (male calf), R15 (cow) - R16 (male calf), R17 (cow) - R18 (male calf).

Association with hand reared female Rhinos

Four rescued, hand reared rhinos were rehabilitated at the rhino camp enclosure during the first phase of rhino translocation. Fifty-eight days post release, one subadult male R1 entered the Boma by breaking the rhino enclosure. All rhinos were female and they did not tend to move outside the enclosure. Since release, they were accustomed to electric shock of solar electric fence

wire surrounding the Boma. However, another male R2 occasionally visited the enclosure but did not enter it.

Association with other wildlife and domesticated cattle

Just following release, the rhinos were seen having a few associations with other wild animals. There were some variation observed among the rhinos released from two source populations, i.e., KNP and PWS. Rhinos translocated from PWS were found to be in close affinity with domesticated cattle and wild buffalo (n=34) and gaur (n=8). A sub adult male R2 liked to share gazing space with one injured gaur just after release. Later, both the two male sub-adult rhinos were united and shared their space with domesticated cattle and buffalo near the southern boundary of Bansbari and Bhuyanpara ranges. These animals (R1 and R2) were observed 44% of the time (out of a total observation n=354) in association with domesticated cattle. A similar affinity with domesticated cattle was also observed with R3 about 4.45% of the time (out of a total n=136); R6 & R7 were observed with cattle for about 4% of the time out of a total observation of (n=254); R5 was observed with cattle for about 3.2% of the time (out of a total n=152); R8 was observed with domesticated cattle for about 3% of the time (out of a total observation of about n=243); R10 was observed with domesticated cattle for about 31% of the time (out of a total observation of n=64). Rhino-11 after reaching Kahitama (the western part of Bansbari Range) area liked to use the same grazing space with one thousand domesticated buffalo and cattle inside the park. However, R11 was found only 8% of the time in association with domesticated cattle (out of a total of individual observations n=147).

Except for the sub-adult rhino R11, there were no such associations observed with rhino translocated from KNP. Around 2,500–3000 cattle graze in the core of PWS every day in association with wild rhinos (Talukdar 1999). Rhinos from Pobitora may have more familiar association with cattle as compared to KNP, where there are minimal rhino and domesticated cattle associations due to strict protection and the nature of terrain like swamp and marshy areas, beels, undulating hill sides etc.

CONCLUSION

Wild to wild rhino translocation in Assam thus far is on track to meet Indian Rhino Vision 2020 goals for achieving the goal of 3000 rhinos by the year 2020. The success of monitoring rhinos during the first 90 days of

release in MNP opened a new dimension in the history of rhino conservation in Assam. There has been little research into free release rhino translocations and this was the pioneering effort in Assam. In other rhino species, there is a great variation in the performance of individual rhinos after translocation and release. (Hofmeyr et al. 1975; Hall-Martin & Penzhorn 1977; Hitchins 1984; Adcock et al. 1998; Brett 1998; Patton et al. 2010). The success of a translocation can be improved with a better understanding of how rhinos behave after release, particularly how much they move, relative to their release site and their pattern of movement in the landscape during early stages of establishing a home range (Linklater et al. 2003). The present study will be helpful in future efforts of greater one horned rhino translocation on recipient site. It was observed that within the 90 days period of translocation, rhinos were settling in on different locations of Manas National Park. So anti-poaching measures were strengthened around these areas.

Release sites must be kept out of disturbance. Transporting vehicles must be parked at least 500m away from the release site. After release, intensive monitoring and patrolling is necessary to track the whereabouts of the rhinos, but with minimum human disturbance. As per colonization patterns observed in Manas, the newly released rhinos immediately required water bodies and surrounding grassland near to the release site. Therefore, release sites must be selected around locations with neighboring water bodies, grass land and far inside the park boundary. It is necessary to conduct rhino monitoring through properly trained rhino monitoring staff with trained patrolling elephants. During our study period, some elephants as well as Mahout (elephant driver) were not well trained for monitoring rhinos. Some elephants were also scared of approaching the rhinos. So just before translocation, recipient sites must develop capacity in this regard. It was observed that the dominant bull (R1 & R2) might influence on the colonization pattern of female calves and sub adult males. Proper observation of such behavior is necessary after release. All recipient sites must be ready with requisite logistics (crates, darting gun, drugs, etc.) to tackle any emergency situation like rhino straying out of the park.

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