Rehabilitation of greater one-horned rhinoceros calves in Manas National Park, a World Heritage Site in India

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Abstract

For the first time in the history of rhino conservation in India, three rescued orphan greater one-horned rhinoceros calves have been rehabilitated in an area that in the recent past was a good habitat for rhinos. The calves were rescued in Kaziranga National Park (NP) when they were about one to five months old when they were swept away by flood waters. The calves were hand reared and nursed at the Centre for Wildlife Rehabilitation and Conservation (CWRC) with the aim of releasing them into their natural habitat. They were fed human milk formula until they reached two years of age, and then with concentrates and greens in paddocks in CWRC. At the age of about three years the calves were translocated to Manas NP, about 500 km away from Kaziranga, and placed in a pre-release area measuring 600 acres. This pre-release area is enclosed with an electric fence and the calves were free to roam and forage within it. After spending about two years in this area the calves were released into Manas NP. The calves were radio monitored for two years; they all survived and created their own home ranges.

Résumé

Pour la première fois dans l'histoire de la conservation des rhinocéros en Inde, trois orphelins du grand rhinocéros unicorne sauvés ont été réhabilités dans un autre habitat qui avait été une zone abritant les rhinocéros dans un passé récent,. Les bébés rhinocéros ont été sauvés dans le parc national de Kaziranga (PN), quand ils étaient âgés d'entre un et cinq mois quand ils avaient été emportés par les inondations. Les bébés étaient nourris au biberon et soignés au Centre de Récupération et de Conservation des Animaux Sauvages (CRCAS) dans le but de les réhabiliter dans leur habitat naturel. Les bébés ont été nourris à la formule du lait humain jusqu'à ce qu'ils atteignent deux ans, puis avec des concentrés et de l'herbe dans les paddocks au CRCAS. A l'âge d'environ trois ans, ils ont été transférés au PN de Manas, à environ 500 km de Kaziranga, et placés dans une zone de pré-relâchement mesurant 600 hectares. Cette zone de pré-relâchement est entourée d'une clôture électrique et les jeunes rhinocéros sont libres de se déplacer et de fourrager. Après avoir passé environ deux ans dans cette zone de pré-relâchement, ils ont été libérés dans le PN de Manas. Ils ont été suivis par radio pendant deux ans ; ils ont tous survécu et on a constaté qu'ils créaient leurs propres habitats vitaux.

Introduction

Rehabilitated animals are now seen as useful scientific resources not limited to the classical theories of individual animal welfare or endangered species conservation (Robinson 2005). When a population is threatened, either globally or locally, released rehabilitated individuals can have a positive effect on the population. Until the early nineties, *Rhinoceros unicornis* had a healthy population in Manas National Park (NP) (26°30′N–27°00′N to 90°50′E–92°00′E), a World Heritage Site in India (Figure 1). Assam

Forest Department (2001) revealed in their internal documents that this population was, however, wiped out due to civil unrest during the late nineties. The civil unrest ended in 2004 following political agreements that led to the formation of the Bodoland Territorial Council (BTC). Thanks to the efforts of BTC and the local autonomous civil administration authority and support from communities around Manas, this important global biodiversity hot spot has regained its protection status. BTC proposed adding an area measuring 950 km^2 to the eastern boundary of Manas NP. The legislative council has endorsed the proposal and this much larger landscape is to be called the Greater Manas; it awaits final endorsement by the State Board of Wildlife, Assam, a statutory body of the government of Assam. This new conservation initiative in Manas is banking on community conservation efforts, a new approach in India. With civil societies collaborating to protect these rhinos, conservation communities asked for them to be urgently reintroduced in Manas NP.

Kaziranga NP (26°33′N–26°45′N and 93°9′E–93°36′E), another World Heritage Site in the northeast Indian state of Assam, has a population of about 2,000 wild greater one-horned rhinos: more than two-thirds of their global population (Figure 1). As Kaziranga NP is situated on the bank of River Brahmaputra, flooding is a natural phenomenon and almost every year about 90% of the park is under flood (Vasu 2003). During each flood, a number of wild animals are dispersed, separated from their mother populations and their land in civil areas. These animals are injured or killed in different circumstances such as in road accidents, by humans or by poachers. To minimize mortality and to have a proper scientific rescue and rehabilitation programme, the Assam Forest Department in collaboration with the Wildlife Trust of India (WTI) and the International Fund for Animal Welfare (IFAW) established the Centre for Wildlife Rehabilitation and Conservation (CWRC) in 2002 at Kaziranga. With 2 biologists, 2 veterinarians and 12 animal keepers, CWRC has been providing all rescue and rehabilitation needs of wild animals in distress in Kaziranga for the last 12 years. In the last 10 years, CWRC has handled more than 3,500 animal rescue cases; more than 50% of these animals were successfully released into the wild. CWRC is a major facility for hand-raising orphaned large

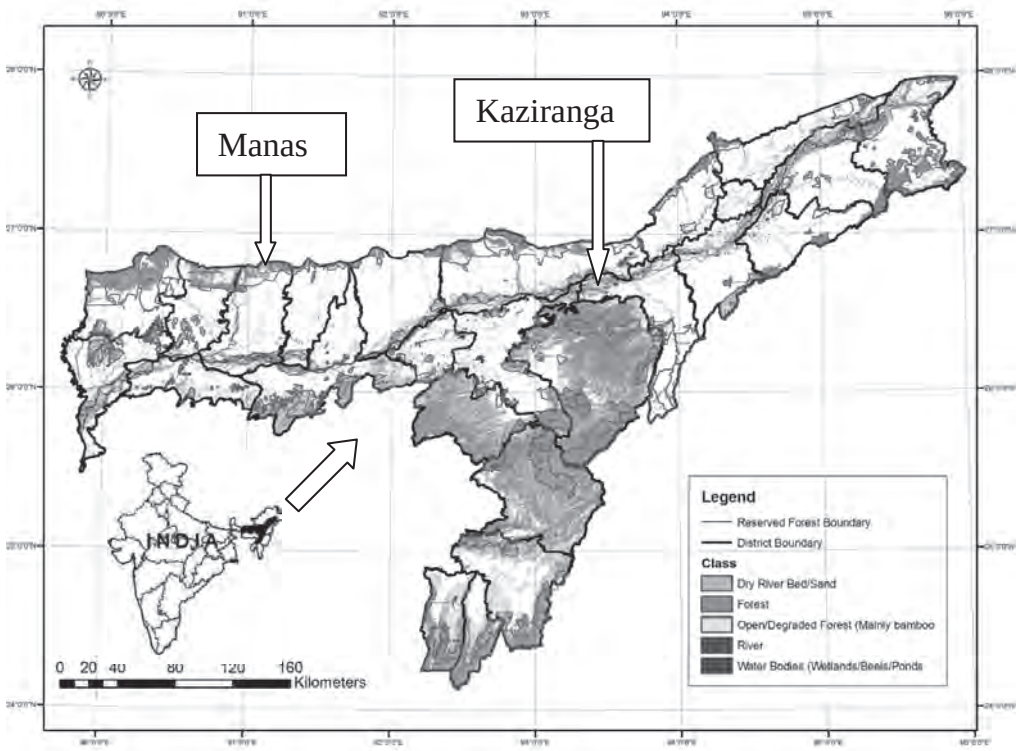

Figure 1. State of Assam showing Manas and Kaziranga NPs.

wild mammals, especially rhino, elephant and wild buffalo calves in northeast India. At this centre, orphan animals spend their time in different housing facilities from nursery to big paddocks, depending on their age at rescue. They are bottle-fed human baby milk formula until they are weaned at different ages, depending on the species. In 2002 and 2004 three rhino calves aged less than five months were rescued in Kaziranga NP after they were separated from their mothers by high flood waters. They were shifted to CWRC for further care and treatment. These animals were later released into Manas NP. This is the first time in the history of rhino conservation in India that rescued rhino calves have been rehabilitated and reintroduced into a natural habitat. Before that, all rescued calves were placed in a zoo and many died while being hand-raised in captivity (pers. comm., Office of the Park Director, Kaziranga NP).

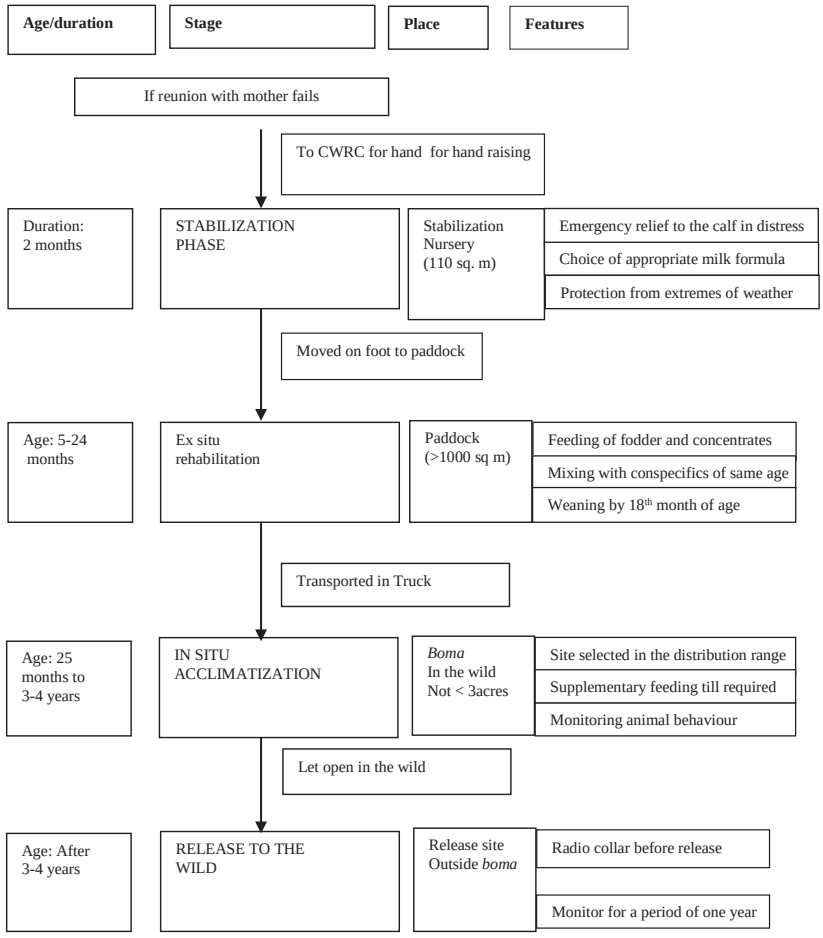

Figure 2. Rhino rehabilitation protocol flow chart.

The process

Wildlife rehabilitation is still in its infancy (Holcomb 1995) and a professional and scientific wildlife rescue and rehabilitation programme is lacking in India (Ashraf and Menon 2005). The best way to reintroduce a hand-raised rhino to the wild is still debated and doing so needs consultation and inputs from various experts. A wildlife rehabilitation consultative workshop was organized at CWRC in 2005 to get expert suggestions and inputs, to share Africa's experiences, and to formulate a protocol for reintroducing these rescued rhino calves (Figure 2). This forum discussed a protocol drafted by a WTI–IFAW team and incorporated expert inputs. This protocol to rehabilitate large mammals in Assam (Ashraf et al. 2005) was later adopted by the Assam Forest Department–WTI–IFAW-run CWRC. It was tested with the rhino calves rescued and admitted at CWRC that were later released in Manas NP.

Rhino calves admitted to CWRC

The first rhino calf was rescued in July 2002 after it was separated from its mother during the floods. It was weak and less than a month old. Two calves estimated to be less than six months old were rescued in July 2004 in similar conditions. CWRC rescued 21 other rhino calves under various circumstances. Flooding is the major cause of displacement of rhino calves in Kaziranga NP. In a few cases, calves were found alone in the forest for unknown reasons; a few were orphans

after poachers killed their mothers, others were failed predation attempts. CRWC took in all these rhinos for treatment and care. While 5 of the 24 rhinos brought to the CWRC were injured, due largely to predation, 4 cases could be attributed solely to floods. Interestingly, almost all the rhino calves with serious injuries were encountered outside the peak monsoon season (July–September). In spite of medical care, all calves that survived predation died from the serious injuries. Critics consider 'rescuing' such calves as disrupting normal ecological processes. Field staff in the park realized that these cases were predation attempts only after taking the animals captive. Park authorities have been advised to adopt a wait-and-watch policy when they encounter rhino calves as they could be cases of predation attempts. Of the 10 calves that died, 6 died within 48 hours of admission, 3 within two weeks and 1 inside the boma at Manas. CWRC veterinarians have found it much easier to hand-raise rhino calves than elephant calves; however, their condition on arrival determines whether they will survive. A healthy rhino calf, even when very young, has greater survival chances than an elephant calf of the same age group. Besides the four rhinos that were relocated to Manas in 2006, 2007 and 2008, CWRC at present has five rhino calves, all males (Table 1).

At CWRC, the calves were placed in a nursery enclosure (~5 m x 5 m), observed for injuries and stabilized. Generally, calves are accompanied round the clock by an animal keeper. Calves were fed diluted human baby milk formula that was available in the market (brand name: Nestogen, make: Néstle) with a special 2-litre bottle with a long rubber nipple. For the first three to four days, they were given milk at one-hour intervals, although this frequency was reduced during the night. Once they were accustomed to drinking this milk, were less stressed and had stabilized, they were allowed to use a paddock (~10 m x 10 m) next to the nursery. After three to four months, varying with the individual, the calves were fed concentrates with mineral supplements and vitamins. From the age of 6 months, they were introduced to fresh greens, mainly grass, and continued with concentrates and milk. They were weaned at two years and fed a diet of greens from then on. Veterinary doctors treated the calves and prescribed appropriate medicines for injuries. At any time, there were two vets at CWRC, ready to handle any emergency with medical interventions.

While the calves were being hand raised at CWRC, procedures had started to select sites where they could be rehabilitated. Though Kukrakata near Kaziranga NP was identified as a possible site for release, the CWRC governing council recommended moving them to Manas NP for rehabilitation and release. Rehabilitation is isolated from the holistic conservation effort when it is not linked to an active conservation programme. Here was an opportunity to link rehabilitation efforts with an active conservation programme. Using rehabilitated animals in reintroduction programmes for establishing new free-ranging populations has greater conservation value than releasing them in areas like Kaziranga where there is already a healthy rhino population.

Two important issues were considered while selecting Manas as the release site. The IUCN *Guidelines on re-introduction* (1998) stipulate that the re-introduction area should have assured long-term protection, and the causes of the species' decline should be identified and eliminated or reduced to a significant level. Cessation of political unrest in the region, formation of the autonomous BTC and resumption of park protection and management activities assured that the project had political support and that poaching in the park has been reduced to insignificant levels.

Following the governing council's recommendation, a site selection committee visited Kokilabari and Bansbari areas in 2005 to assess the area. This committee consisted of the chief wildlife warden of Assam, the directors of Manas and Kaziranga NPs, all range officers of Manas NP and representatives from WTI. Site selection criteria were developed based on the IUCN (1998) guidelines on re-introduction that had the following set of suitability criteria: the site falling within the rhino distribution range; availability of adequate cover, food and water; minimal presence of human settlements in the area; reports of minimal livestock grazing and human trespassing; habitat suitability in terms of vegetation composition; accessibility of the site for monitoring; reports of livestock diseases reported from the area; how prone the site is to flooding during the monsoon; and availability of reports of hunting, poaching and insurgency in the area. Three sites within Manas were selected: Kuribeel, Uchila and Kokilabari. The committee considered the advantages and disadvantages of each site, and the Kuribeel area of Bansbari Range in Manas NP was chosen as the site in which to establish the rehabilitation station. Kokilabari has less grassland area, few perennial water bodies and high human intervention; Uchia is located deep in the

Table 1. List of rhino calves admitted at CWRC for various reasons since 2002

Sl no.	Date of admission	Place of rescue	Stage/sex	Cause of displacement	Outcome	Date of outcome
1	21/01/2013	Kaziranga	Infant female	unknown (found alone)	died in captivity	31/01/2013
2	23/09/2012	Haldibari	Neonate female	flood/river induced	died in captivity	19/11/2012
3	01/07/2012	Baghmari	Infant male	unknown (found alone)	alive	N/A
4	27/10/2011	Burapahar	Infant female	unknown (found alone)	died in captivity	27/10/2012
5	10/03/2011	Hathikhuli	Neonate male	injury (unknown)	died in captivity	22/03/2011
6	15/02/2011	Karetapu	Infant female	unknown (found alone)	died in captivity	04/03/2011
7	19/12/2010	Agoratuli	Neonate male	orphan (parent killed)	alive	N/A
8	08/03/2010	Kathpora, Kohora	Infant female	stuck in mud	died in captivity	15/03/2010
9	10/09/2009	Baghmari, Baguri	Infant male	unknown (found alone)	alive	N/A
10	21/08/2009	Haldibari	Neonate male	unknown (found alone)	alive	N/A
11	13/03/2009	Baruntika Camp, Baguri	Infant male	unknown (found alone)	alive	N/A
12	09/02/2009	Bokhpora	Infant male	orphan (parent killed)	alive	N/A
13	31/01/2008	Gerakati, Baguri	Infant male	unknown (found alone)	alive	N/A
14	22/09/2007	Hatikuli, Kohara	Neonate female	orphan (parent killed)	died in captivity	06/10/2008
15	11/09/2007	Deopani, Baguri	Infant male	injury (unknown)	died in captivity	12/09/2007
16	16/10/2006	Japoripothar	Neonate male	injury (predation)	died in captivity	16/10/2006
17	20/06/2005	Baguri	Neonate female	injury (unknown)	died in captivity	20/06/2005
18	09/01/2005	Ajagar camp	Infant female	unknown (found alone)	died in captivity	27/01/2005
19	09/12/2004	Dumjan	Infant male	injury (predation)	died in captivity	28/12/2004
20	22/07/2004	Harmoti, Baguri	Infant female	flood/river induced	released	27/11/2008
21	14/07/2004	Baghmari,	Infant female	flood/river induced	released	27/11/2008
22	06/03/2003	Kaziranga	Infant male	injury (predation)	died in captivity	06/03/2003
23	06/08/2002	Kaziranga	Infant female	flood/river induced	died in captivity	07/08/2002
24	28/07/2002	Kaziranga	Infant female	flood/river induced	released	27/11/2008

park and it was likely there would be problems with regular monitoring of the area. The presence of a few watchtowers around Kuribeel area ensured 24-hour rhino security. As the plan was to move the rhinos in trucks, it was also important to have the pre-release area located along an existing forest camp road.

The boma: pre-release area

The pre-release area in Kuribeel—called a 'boma', as this is what a similar enclosure is called in Africa—was surrounded by a solar-powered electric fence. It had three compartments: compartment A was ready when the first rhino was moved, and as soon as compartment B was completed, the rhino was allowed to use both areas (Figure 3). The boma also included part of a perennial stream because rhinos need water bodies to wallow in during the hot hours of the day. Hume pipes (large cemented pipes) were placed below the fence to facilitate the free flow of stream water through the boma. The nine-strand power fence had a twin role: to keep the rhinos confined in a large area for at least two years and at the same time keep away wild elephants and large carnivores like tigers. A corridor measuring 20 m x 70 m was created between sections A and B in case the rhinos needed to be confined for medical intervention. Two more rhinos were relocated to the boma in 2006 and another rhino calf was rescued in September 2007. The boma was expanded to double its existing size. Accordingly, 19 acres were added as compartment C in January 2008, just before the fourth rhino was relocated. All three compartments together measure 33.35 ha and were sufficient to accommodate the four rhinos until they were released.

Relocating rhinos to Manas NP

Early in 2006 WTI partnered with BTC to reintroduce rhinos into Manas NP from Kaziranga. IUCN guidelines (Emslie et al. 2009; Suwal and Shakya 2002) were used to plan and translocate the hand-raised rhinos. The first rhino, a three and a half-year-old female christened Maino by BTC, was moved to the boma on 21 February 2006. Maino thus got the distinction of being the first rhino to reach Manas after the resident population of rhinos had been wiped out during the decade of political instability in the region. On 28 January 2007, two more female rhinos, Rose and Manasi, were relocated from CWRC to the same boma. After a month of habituation at CWRC the rhinos were each lured into a crate, and a long-acting tranquilizer, Azaperon (Stressnil), was administered intramuscularly to reduce aggression and minimize damage to the crate. With the use of a crane the crates were loaded onto individual trucks that travelled by road overnight for about 400 km.

On 23 February 2008 a female rhino calf about two years old was translocated from CWRC to Manas NP, raising to four the number of rhinos inside the boma. This rhino had been rescued from Hatikhuli Tea Estate near Kohora after poachers killed its mother. While the rhinos that had been moved to Manas earlier were all hand raised, this calf was already two years old and was therefore considered to have been already weaned off milk. Consequently, luring this calf into the transportation crate was not considered an appropriate option for trapping it. We used a combination of Meditomidine and Ketamine hydrochlorides to restrain it before placing

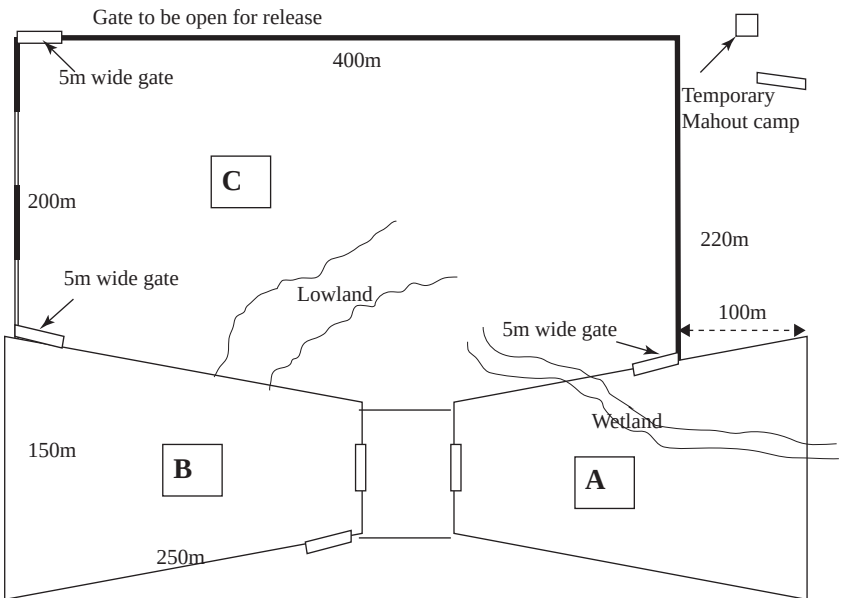

Figure 3. Schematic diagram of the boma used for rhino rehabilitation.

A calf under rehabilitation at CWRC is bottle-fed milk.

it on the sledge and dragging it into the crate. To give the rhinos a sense of familiarity to the new area, bags of their fresh and old dung had been taken to Manas from CWRC the previous day and scattered on the ground. The next morning after the trucks reached Manas, the young rhinos were let out of their crates into the boma. All four rhinos have been radio-collared to enable post-release monitoring. Within two months of relocating the fourth rhino to Manas, two male rhinos from Pabitora Wildlife Sanctuary (WLS) were hard-released (caught in the wild and directly released in Manas without using a pre-release boma) in Manas as part of the Indian Rhino Vision 2020 (IRV 2020) rhino translocation programme of the government of Assam. The female rhinos translocated from CWRC to Manas have a chance to choose mates while they are rehabilitating in Manas NP.

Rhinos at the boma

The rhino calves admitted to CWRC were hand-raised for about 18 months. Unlike elephant calves, they were held in large stockades at the centre until they were considered fit enough to be relocated to the boma at the release site. Since rhino calves begin nibbling grass blades by the age of 2–3 months, grass and browse were made available to them by the time they were four months old.

A 'soft-release' strategy was adopted after holding the rhinos in captivity at the release site for two to four years, depending on the age of the rhino at the time of its relocation. All rhinos were given supplementary feeding, a concentrate mix, for a week following their relocation. Supplementary feeding stopped as soon as they became accustomed to the grazing area inside the boma.

The fourth rhino was much younger and she was held initially in a small paddock specially created within compartment A, before she was allowed free access to the entire compartment. The plan was to restrict the calf to this compartment until the other three adult or subadult rhinos occupying compartments B and C were released. However, one of the male IRV 2020 rhinos strayed more than 100 km from Manas, creating panic among people, and had to be captured and released into the boma. The second male rhino, possibly lured by the three females inside, had already forced his way into the boma by disrupting the power fence on 10 June 2008. Fortunately, this happened on the side harbouring compartments B and C where the adult rhinos were held and not in compartment A. However, releasing the straying rhino into the boma through compartment A had serious consequences. The standard operating procedures were overlooked and the calf was left among adult and subadult rhinos with all compartments interconnected. On 14 September 2008 the young female calf was found dead. The carcass was discovered only after a couple of days by which time putrefaction had started and scavengers had devoured the carcass considerably. Mandibular fracture and other circumstantial evidence pointed to death due to traumatic injury caused by the adult rhinos. Though fingers were pointed at the wild captured rhinos, there was no clear evidence to support this.

Data were collected on rhinos' use of habitat within the boma, and rhino behaviour towards caretakers, strangers, conspecifics and other wildlife was recorded anecdotally. Initially, the animals were seen following the caretaker whenever he inspected the fence for repairs. A month later the monsoon set in and tall grass grew inside the boma that soon cut down the visibility of the rhinos from outside. Three months after they were released, the rhinos showed little concern for people patrolling around the fence, though they were at times heard vocalizing on noticing human presence.

The tall grass was cut to encourage the growth of fresh blades of grass. The rhinos were moved from one compartment to another and the grass was trimmed close to the ground. Burning the grass would have been a better option but was not done as the fire might have gone out of control and spread into the other compartments holding the rhinos.

Release and post-release monitoring

On 27 November 2008, the park authority and WTI representatives visited the pre-release site at Bansbari to assess whether it was feasible to release three female rhinos from the boma. The Rhino Task Force meeting of the government of Assam held in September 2008 had proposed that these rhinos be released. The team found all conditions favourable and released the rhinos from the pre-release site. On 27 November 2008, the gate of the boma at the northern-most boundary was opened and two female rhinos came out immediately. The third female rhino only ventured out the next day. At the time of release, one of the females was over six years old and the other two nearly five years. Meanwhile, the two male rhinos continued being held in the boma till 3 May 2009 when the younger forced his way out, once again by breaking through the power fence. The reason was said to be persecution by the other male inside. Once part of the southern boundary of the park was power fenced, the other male rhino was also let out, on 25 November 2009. This was exactly one year after the three rehabilitated rhinos had been released from the boma. Soon, the male and female rhinos were seen grazing together, often occupying the same habitat.

The rehabilitation protocol emphasized that the rhinos be monitored intensively for one year post-release (Ashraf et al. 2005; Emslie et al. 2009). But the rhinos were monitored for more than this designated period. In spite of collaring them as early as 2006 and 2007 respectively, the collars continued to give signals till the end of 2009 and beginning of 2010. Collars therefore provided range-use data for more than the stipulated period of one year post-release. Manasi's collar fell in October 2009, and Maino's in February 2010. Rose's collar is on the verge of falling due to normal wear and tear. The collar stopped functioning, but not before providing the tracking team with information on her movement patterns for more than a year. All rhinos were intensively monitored till 31 March 2010.

Female (rehabilitated) and male (hard release) rhinos graze in Manas National Park.

Radio-tracking was done largely using a vehicle, but sometimes on foot and rarely on elephant back. Temporary watchtowers were erected at strategic locations, especially near the southern park boundary towards the village site, to facilitate easy tracking. Having been held in captivity in the boma for more than two years, the rhinos had developed site fidelity and as a result did not wander long distances after their release, unlike the hard-released males. Tracking these animals was therefore much easier as they rarely went

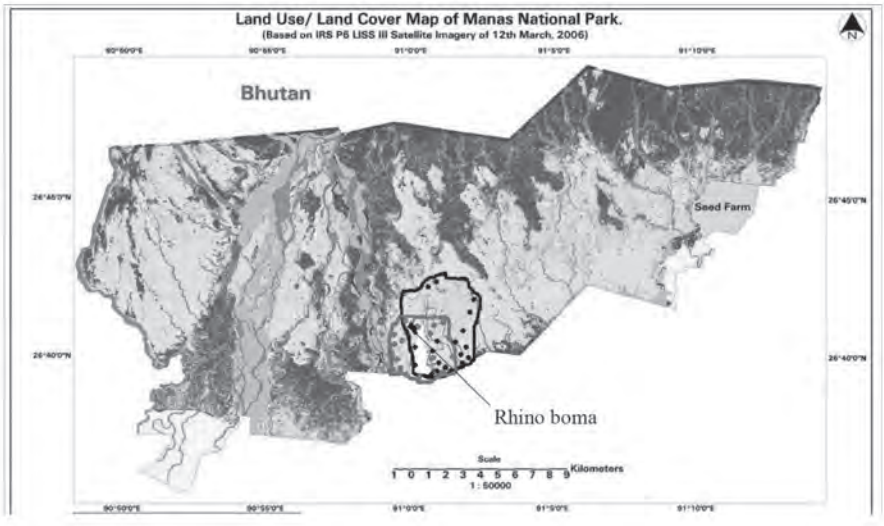

Figure 4. Home range of rehabilitated rhinos in Manas National Park.
Key: solid line = Maino; broken line = Manasi and Rose

beyond the coverage area of the radio-transmitter. As they were also habituated to the caretakers, watching them from close quarters did not hamper their normal behaviour. However, they were never seen to approach humans as was the case during the first six months of being released into the boma in 2006 and 2007 respectively.

Range extension and habitat use: first six months post-release

The rhinos did not have a chance to re-enter the boma as the gates had to be closed for the two male rhinos to be held captive till the southern boundary of the park was power-fenced. However, true to the nature of soft-released animals, the initial range utilization of all the three rhinos had a close association with the boma. The two younger females (Rose and Manasi) were confined to the perimeter of the power fence for the first two months after their release. Within six months, Maino had established a home range of about 15 km^2 and Rose and Manasi a considerably small home range of 7–8 km^2 (Figure 4). Maino extended her range towards the south and southeast of the boma up to the fringe areas of the southern boundary. The farthest distance she travelled from the park boundary was 1.5 km up to Barengabari village. From the boma the northern limit was 2.5 km and movement towards east during the first six months of release varied from 2 to 5 km. It was apparent that the movement to the south and southeast of the boma was for the aquatic vegetation on the Giati River and short grassland in the fringe areas where livestock grazing and other biotic pressure is high. In May 2009, her movement pattern almost coincided with that of the male rhino that had escaped from the boma on 3 May 2009. By September 2009, all three rhinos not only showed a general increase in their range use, but also a shift in habitat use pattern, which was possibly determined by the physiognomic changes in ground vegetation. Because of her frequent association with the male rhinos, Maino's range use often coincided with the movement pattern of the males. As a result, she also strayed out of the park repeatedly during the day and up to four or five times during May 2009. By placing an animal tracker solely for guarding against this at the Palsiguri beat of the southern boundary of the park, the situation could be brought under control. However, after the power fence was erected on the Bansbari side of the southern boundary, incidents of straying have not been reported.

Maino avoided the tall grasslands being routinely burned in January 2010 and instead used swampy grasslands more. As soon as new blades of grass emerged in the burnt areas, the rhino began frequenting these patches. In January, Maino was associated with one of the IRV 2020 male rhinos and both disappeared from the scene for nearly a week. With no signal being received from Maino for five days, intensive search led to her being spotted in the Tower camp, northeast of the boma.

Range extension and habitat use: the last six months (October 2009–March 2010)

By March 2010, Maino had extended her range further to the northeast of the boma (Figure 5). The animal was no longer sighted frequently in and around anti-poaching camps. This could be because short grasses and aquatic vegetation were abundant everywhere. The rhinos in Manas most frequented areas with short grass and aquatic vegetation. Unlike Rose and Manasi, Maino explored newer areas that are also used by the

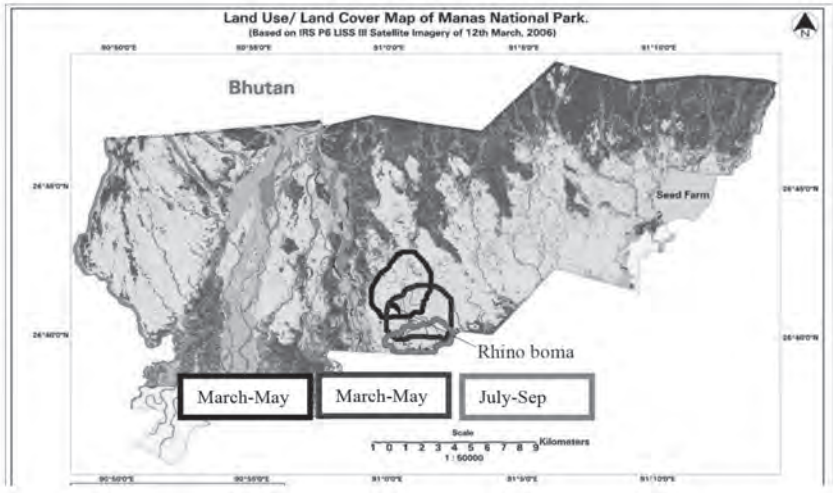

Figure 5. Shift of home ranges in different seasons.

Releasing a rhino from CRWC into Manas National Park.

adult male rhinos. For instance in March, she was sighted with a male rhino in Bangale Hatdhua area, long after her collar had dropped.

While Maino had her own range-use pattern, often associating with the males, Rose and Manasi were always found moving together. In March 2010, both rhinos were seen using the elephant training camp, boma and Bathan areas. However, it was not uncommon to see all three in one location for a brief period.

The one year of radiotracking rehabilitated rhinos ended, and intensive tracking formally came to an end on 31 March 2010. The rhinos are still physically tracked and their GPS locations, habitat use, association with conspecifics and activity recorded anecdotally. By April 2010, the home ranges of Maino and the other two females were almost equal, each occupying 15–20 km^2. It will be interesting to compare the home ranges of these rhinos with those of the wild-caught males hard-released in Manas.

Lessons for the future

Transportation age: All three rhinos (except the fourth, which died in the boma) were relocated to Manas when they were about three and a half to four years of age. It would be better to move them much earlier, say by two years, as this would shorten the time caretakers would be needed at CSRC. It is also much easier to move younger rhinos.

Protecting offspring: Experience in Dudhwa NP has shown that reintroduced rhinos have little chance of protecting their calves from tiger attacks. In Kaziranga NP, rhinos lose a considerable number of their calves to tigers. The 2,000 odd rhinos in Kaziranga can withstand this occasional removal of individuals from the population, but this may not be the case in Manas. The rhinos with newly born calves may have to be confined to the boma to protect their calves till they are about two years old.

Relocating the boma: In a soft-release programme, animals tend to establish their home range close to the area of their acclimatization. To spread out the distribution of the rhinos in the park and to reduce pressure on the southern boundary, future releases might have to be deep inside the park in areas like Uchila and beyond. The boma might have to be relocated to ensure that this happens next time when orphan rhinos are moved to Manas.

Time of collaring rhinos: Since a considerable amount of battery life is lost by collaring the rhinos before their relocation, in future the animals should be collared only when they are about to be released from the boma. Experience has shown that the rehabilitated rhinos do not break the fence and venture outside. They can always be captured and returned to the boma should an emergency of this sort happen.

From rescue to release: the success of rehabilitation

The successful rehabilitation of rhinos in Manas NP can be recapitulated in the following stages:

1. Rescuing the calf from distress: When attempts to reunite calf with mother fail, the calf is taken to CWRC for hand-raising. In the last 10 years of experience at Kaziranga NP, not a single rhino calf has been reunited with the mother. This is in contrast to elephants wherein at least seven calves have been successfully reunited.

2. Hand-raising: All calves are stabilized upon arrival in captivity. Depending upon their hydration levels, fluid therapy is given where necessary. A standard milk formula is employed. The calves are weaned by 18 months of age and unlike elephant calves, rhino calves begin nibbling blades of grass even before they turn two months of age.

3. Translocating: Weaned calves spend another one year held in a 2–3-acre bamboo paddock reinforced with live wire at CWRC. Husbandry practices include providing adequate fodder (largely grass) and a suitable concentrate mix of gram, cereal, vitamins and mineral supplements. At the time of translocating them, they are either habituated to a crate or chemically restrained

and dragged into it, and moved to the release site in a truck after their radio collars have been placed.

4. Acclimatizing to the release site: Following translocation, the rhinos are held in the boma for a minimum of two years to acclimatize to the local conditions. Apart from managing the habitat within the enclosure, no other husbandry practice is followed here. Such a soft-release programme also helps the animals become loyal to the site.

5. Release and monitoring: The boma gates are opened and the rhinos released into the wild after the period of acclimatization is over. They are then radio-tracked for one year post-release and valuable data on their habitat use, range extension, social interactions with conspecifics is collected. The collars either drop on their own or are made to drop using a pre-programmed device.

Conclusions

The project has demonstrated that hand-raised rhinos can successfully contribute to the reintroduction of rhinos to Manas NP. With five more orphaned rhino calves waiting to be moved to Manas in the next two years and more wild rhinos being planned for addition to Manas as part of the IRV 2020 programme, the conservation scenario looks bright as far as the return of rhinos to the park is concerned.

All IUCN guidelines have been adhered to, not only in formulating the rhino rehabilitation protocol (Ashraf et al. 2005; Emslie et al. 2009), but also during the implementation of the project. All the required permissions from the chief wildlife warden of the state, from the Ministry of Environment and Forests and from the Central Zoo Authority were obtained in advance. All rhinos were also screened for infectious diseases before they were moved to Manas NP following the appropriate protocol (Woodford 2001). The rehabilitated rhinos have contributed to the return of this species to the once-renowned Manas National Park.

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FIELD NOTES

Decay rate of elephant dung in Conkouati-Douli National Park, Republic of Congo

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Introduction

Dung surveys are commonly used to monitor elephant (*Loxodonta africana cyclotis*, Blumenbach, 1797) populations in forest environments. To estimate elephant density from dung density two parameters are required: 1) the dung deposition rate, and 2) the rate of dung decay (Barnes and Jensen 1987; Barnes 1996; Theuerkauf and Gula 2010; Vanleeuwe 2010). The rate at which elephant dung decays is non-linear and is affected by numerous variables including environmental factors such as rainfall, exposure to sunlight, and temperature, and biological factors such as elephant diet and the action of decomposers, particularly fungi and insects but also small mammals foraging for seeds. These complex interactions result in seasonal, inter-site and intra-site variation in decay rates (White 1995; Barnes 1996; Barnes et al. 1997; Breuer and Hockemba 2007; Theuerkauf et al. 2009). For this reason it is recommended that researchers conduct their own studies of dung decay rates to ensure accurate population estimates (Hedges and Lawson 2006).

Study site

Conkouati-Douli National Park is located on the southern coast of the Republic of Congo, along the border with Gabon. The park covers an area of 5,050 km^2; approximately 76% (3,850 km^2) of it is terrestrial and the remaining 24% (1,200 km^2) forms the Republic of Congo's only marine protected area. Conkouati-Douli is the most biodiverse protected area in Congo, encompassing a wide variety of habitats and species. The park is classified as a RAMSAR site for its important wetlands birdlife; it is a listed candidate to become a UNESCO World Heritage Site and is a high priority site for great apes in the IUCN Great Ape Conservation Action Plan due to its large number of Central African chimpanzees (Vanleeuwe and Morgan 2012).

Methods

Seasonal movement patterns result in a large variation in elephant numbers. To control for this variation, dung counts are ideally conducted at the end of a season, ensuring that dung piles recorded during the count were deposited in the elapsed season. Dung decay studies are therefore best conducted during the same season that dung counts are conducted. In Conkouati-Douli, onset of the rains renders the terrain difficult to access and dung counts are therefore conducted at the end of the dry season, before onset of the rains.

The elephant dung decay study therefore took place during the dry season to make the results pertinent for elephant monitoring in Conkouati-Douli. A large herd of elephants was spotted around the park headquarters at the onset of the dry season, allowing us to tag 57 dung piles that were all less than 24 hours old at the start of the study.

Dung piles were marked and the habitat, canopy cover and slope were recorded for each pile. Canopy cover was classified into four categories as 0) no

Table 1. Stages of decay as per Barnes and Jensen, 1987

Stage	Condition of dung pile
A	pile intact, very fresh, moist, with odour
B	pile intact, fresh but dry, no odour
C1	more than 50% of the pile is distinguishable, some has disintegrated
C2	less than 50% of the pile is distinguishable, the rest has disintegrated
D	pile completely disintegrated, forms a flat mass
E	decayed to the stage where it would be impossible to detect at 2-m range in the undergrowth, and it would not be seen unless directly underfoot

canopy, 1) 0–25% cover, 2) 25–50% cover, and 3) 50%+ cover. Slope was classified as: 0) no slope, 1) 0–25% incline, 2) 25–50% incline, and 3) 50%+ incline.

Dung piles were monitored weekly and their stages of decay classified according to Barnes and Jensen (1987). Dung piles were considered fully decayed when they reached stage E (Table 1).

As the exact number of days between the final observation of dung as stage D and its transition to stage E was unknown, a random number between one and seven was added to calculate survival time and decay rate (Barnes et al. 1997; Breuer and Hockemba 2007).

Results

A total of 57 dung piles were monitored from March to September 2005. The majority (75.4%, n = 43) were found in forest habitat with 12% (n = 7) in scrub, 10% (n = 6) in savanna grasslands and 1.8% (n = 1) in farmland. Mean survival time of dung piles was 158.3 days (SD ± 12.6, 95% CI 1551–61); the mean rate of decay was 0.00637 per day (SD ± 0.0007, 95% CI 0.0618–0.0656). Dung survival ranged from 89 days to 174 days; however, all but one of the dung piles survived for a minimum of 147 days. There was no significant difference in the survival time of dung piles by habitat type (Kruskal-Wallis, X^2 = 1.616, df = 3, p = 0.656), canopy cover (Kruskal-Wallis, X^2 = 5.839, df = 2, p = 0.054) or slope (Kruskal-Wallis, X^2 = 2.212, df = 2, p = 0.331).

Conclusions

Investigating dung decay rates across a large landscape can be a laborious undertaking involving significant commitment to time and resources (Kuehl et al. 2007). By opportunistically targeting a large herd near the research station, we ensured that all dung was less than 24 hours old at the start of the study, which minimized the effort needed to monitor the dung piles. The study was carried out entirely during the dry season to ensure dung decay rates were relevant to elephant monitoring in Conkouati-Douli, which takes place at the end of the dry season.

The survival time of dung piles in Conkouati-Douli is one of the longest reported in the literature. Variation in survival time was also low relative to similar studies. These differences may be partly due to many studies reporting combined figures for wet and dry seasons (e.g. Breuer and Hockemba 2007; Olivier et al. 2009). While we did not detect any effect of habitat type, canopy cover or slope on dung pile survival time it is likely that this was due to the small sample size and low variability in survival time.

Further study is needed to fully understand the factors affecting the decay rate of elephant dung piles in Conkouati-Douli. Nevertheless, this study provides a site-specific decay rate for Conkouati-Douli, which has been used to calculate the elephant population in 2005, 2008, 2010 and 2013.

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