

Studies on Greater one Horned Rhinoceros Behaviour and Ecology with Special References to Wild to Wild Translocated Rhinoceros: A Review

Greater one horned rhinoceros behaviour and ecology is one of most important subject to understand the survival of the animals. There are very limited studies on behavioural and ecological aspects of the animal. This study highlights general behaviour and ecological study of rhino in wild and during the process of reintroduction. As limited rhino translocation process undertaken last couple of decades in India and Nepal so minimum scopes of research in these aspects. Translocated rhinoceros behaviour and ecological studies based on previously accomplished wild rhinos' studies of different rhino bearing areas of India and Nepal. This study highlights both wild and reintroduced rhinoceros behaviour and ecology part as these are two vital aspects to protect and preserve the species in the donor and recipient sites of rhino ranging areas.

Key words: Rhinoceros, Translocation, Ecology, Reintroduction, Behaviour, Association.

Introduction

The greater one-horned rhinoceros (GoH), (*Rhinoceros unicornis*) is one of the threatened megaherbivores surviving on the earth. Rhinoceros are globally threatened due to habitat conversion, fragmentation and poaching to fulfill the illegal demand of their horn and body parts. Like other mega-herbivores, the rhino's populations are mostly confined to small, isolated protected areas (Owen-Smith, 1988). Fragmented populations are at risk of local extinction due to demographic, genetic and stochastic environmental events. Further, the growth of populations in a fixed space increases the competition for space and other biological resources leading to more frequent fights for dominance that result in injuries. This highlights the need to provide more space for long-term conservation of the species (Emslie et al., 2009).

Translocation has become a routine in a number of African rhino range states and has played a vital role in increasing both White and Black rhino numbers. The process of translocation has helped Africa's Southern White rhino's population to increase 10 times in recent past. Similarly, translocation has also played a key role in increasing black rhino numbers in major range states in Africa.

In contrast to African rhinos, there are few scopes to study the translocation process for GoH. In Nepal, 92 (88 to Bardia National Park and 4 to Suklaphanta Wildlife Reserve (WR) individual rhinos were translocated to Bardia NP and Suklaphanta WR from Chitwan NP of Nepal during 1986 - 2016.

The first rhino introduction programme in India was to Dudhwa National Park (Uttar Pradesh) from Assam in the year 1984 where four individuals were translocated, with four more brought from Chitwan National Park, Nepal to the park. Reintroduced population of Dudhwa National Park gradually recovered to 32 individuals in 2018 (Sinha and Swarkar, 1994).

As a part of Indian Rhino Vision 2020 (IRV2020) range expansion program in Assam, 18 rhinos were translocated to Manas National Park (MNP) from

Rhino translocation is new conservation initiatives in Indian subcontinent. In this extensive and crucial process, post-released monitoring and research is treated as priority subject for the success of translocation programme.

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Pobitora Wildlife Sanctuary (PWS) and Kaziranga National Park (KNP) during the period 2008 to 2012 (Dutta *et al.*, 2017).

Following Manas translocations two females (mother and calf) were translocated to Burhachapori Wildlife Sanctuary in the year 2015 both the rhinos died. The Government of Assam and Wild Life Trust of India (WTI) translocated 13 rhinos from CWRC (Centre for Wildlife Rescue, Rehabilitation and Conservation, KNP, Assam) to Manas under the rescue and rehabilitated program from the period 2006 to 2018. Recently, (April, 2018) four rhinos has been translocated from Dudhwa National Park to Belray arange of Dudhwa Tiger Reserve.

Results

General Behaviour Studies on Rhinos

There were plentiful accounts on the behaviour of Indian rhinos since the past. Many British sports person, military officer, hunters, surveyors had documented general encounter based behaviour account of GoH. Scientific studies on rhino's ecology and behaviour were pioneered by Gee (1950, 1964) in Kaziranga of Assam. Gee (1953a, 1953b, 1954) documented mating, aggressive and territoriality behaviour of rhinos in Kaziranga and mentioned that two factors govern between mating of rhinos-the receptivity of the female and the sexual preparedness of male.

Ali (1950) and Ripley (1952) surveyed rhinos population of Brahmaputra valley of Assam in the year 1949 and documented general behaviour (feeding, wallowing, resting) of rhinos. Ripley (1952) studied the territorial and sexual behaviour of rhinos. He noted that the rhinos maintain loose territory covering average 20-50 acres of areas encompassing beels and swamps.

Kakoti and Rajkhowa (1972) documented the reproductive behaviour of rhinos in captive in Gauhati zoo, Assam. They recorded a female rhino's first mating age to be about 5 years 21 months, gestation period 16 months and inter calving period 28 months. Ulrich (1964) studied social behaviour and social organization of rhinos in KNP and noted they maintained loose territory as well as social bonding in rhinos. Lahan (1974) studied the aggressive behaviour of rhinos in respect to territoriality, mating, association and sex in KNP.

The most detailed work on GoH was carried out by Andrew Laurie in the Chitwan Valley of Southern Nepal last seventy decade. Laurie (1978) exclusively studied rhinos distribution, behaviour and habitat patterns. He reported that rhinos are predominately solitary but temporary association was also observed during wallowing, mating and feeding. He observed that the rhinos spent 36% feeding, during monsoon, 57% in winter and 65% in spring season. He noticed loose territory of breeding adult males and recorded 10 auditory displays among rhinos. Laurie (1982) mentioned rhinos' territoriality, communication and vocalization, wallowing, defensive, interaction, and reproductive behaviour. He recorded females first calf at a mean age of 7.1 years and the median inter-calving interval was 2.8 years. He also noticed that young shoots of the tall grasses made the bulk of the diet in the spring season, short grassland during monsoon and scrub and short grassland during the

winter season and frequency of wallowing was lower in colder days during monsoon but rain itself did not result in an immediate reduction in wallowing.

Dinerstein and Wemmer (1988) studied frugivorous habit of *Trewia nudiflora* in Chitwan Valley. They have also studied the role of rhinoceros in seed dispersal of the studied tree species. Dutta and Bhattacharya (1991) documented daily activity pattern of rhinoceros in KNP. They observed the general pattern of grazing during early morning and late evening and reported that in March, rhinos exhibited grazing activity from 5:00 am to 9:25 a matter which they enter wallowing pits till evening. They also observed the nocturnal grazing activity of rhinos from 5:00pm-11:00 pm. They mentioned that rhinos graze whole day in colder and cloudy day irrespective of seasons.

Ghose (1991) did behaviour studies of rhinoceros in relation to different ecological aspects at Jaldapara WLS of West Bengal. He mentioned that short grassland with perennial water bodies is most important factor for species productivity. Dutta (1991) documented a detailed account of rhinos behaviour in KNP and he mentioned that the rhino's behaviour is restricted to 'eat, sleep and wallow' and very limited period devoted on other activity.

Yadav (2000) documented the aggressive behaviour of male rhinos in Jaldapara NP, West Bengal. He recorded the temporary association between adult male and female during mating season. He observed that during the mating season, dominant bull shows antagonistic behaviour to other male rhinos. Behaviour like squirt urination, digging earth with hind legs, rubbing horn in medium girth size trees, approach to other weaker rhinos with widely opened mouth to overpower are common signs of pre-mating.

Patar (2005) studied feeding, wallowing, resting, territoriality and social behaviour of rhinos in KNP. He observed that due to territorial nature of dominant adults, breeding males have maximum access to available resources like food, water, space, and mates than other weak male rhinos. The territorial bull tries to keep the potentially estrous adult female within its territory for a few weeks. He found rhinos generally graze during the late afternoon, evening and night. Rhino commonly preferred wallowing on 8:00-16:00 hours in the wet season and between 9:00-14:00 hours in dry season.

Hazarika (2007); Hazarika and Saikia (2010, 2012) documented the general behaviour of rhinos, feeding pattern and seasonal food preferences in RGONP, Assam. They revealed two fundamental and basic types of behaviour, the breeding and non-breeding behaviour. They categorized 14 major behavioural patterns in respect to their daily activity. Hazarika *et al.* (2013) studied activity budgeting of rhinos with the support of Scan sampling and Ad Libitum sampling method. As per their study, it was revealed that rhinos displayed distinct behaviour variations throughout the year.

Bhatta (2011) documented feeding, territoriality, aggression and stray pattern of rhinos at PWS. According to his study, the habitat of rhinos at PWS degraded extensively due to different types natural and anthropogenic pressure. Rhino population also reached up to the carrying capacity level of PWS. Therefore,

rhinos frequently stray out to distant areas from the park in search of food and shelter.

Behaviour studies of translocated Indian Rhinos

Sale and Singh (1987) documented the detailed account of rhino translocation to Dudhwa NP and their adaptive nature in a new environment. They reported that initial behaviour patterns (feeding, movement and association) of rhinoceros were monitored daily basis and observed normal. Sinha and Swarkar (1994) analysed ten years of Dudhwa rhino introduction program and showed concern on the aggressive and intolerant behaviour of lone adult bull (Bankey) to other sub-adult and inbreeding threat to reintroduced rhino population.

Jnawali (1995) studied the behaviour of that small population of rhinoceros at Bardia NP in relation with ecological aspects during 1990-1993. He observed the differences in ranging behaviour between donor and founder population. These attributed to low animal density and suddenly changed animal sex ratio. After translocation, founder population bred at a same high rate as recorded donor (Chitwan NP) population. Study revealed that high breeding rate and low mortality rate of calves and adult indicated adequate quality habitat of Bardia NP.

Dinerstein (2003) documented the behaviour of rhinos in Bardia NP. He recorded seasonal behaviour changes in Bardia rhinos in comparison to the Chitwan rhinos. He correlated behaviour (feeding and wallowing) of rhinos to prepare protection strategies of the park.

Sinha *et al.* (2011) studied the social and mating behaviour of rhinos at Dudhwa NP. They observed that rhino population increased from 5 founder rhinos to 30 rhinos which include 25 new born calves within 25km rhino enclosure. All these calves born are the progeny of single dominant male-Bankey (the adult male). So, they predict inbreeding depression in that small rhino population which is a threat to genetic viability.

Tripathi (2013) documented the social and reproductive behaviour and provided some important suggestions to incorporate in management strategy rhinoceros population at Dudhwa NP. He also observed male and female association only in mating season within 25km rhino enclosure. The most common association was found in mother and calf and among sub adults. Mating behaviour constitutes whistling, running, chasing, aggressive nature occurs prior 6-10 hour of copulation.

Bonal *et al.* (2009) documented the process of translocation and dispersal pattern of rhinos after the release of two adult males at Manas. They reported that immediately after release rhinos they were ran for about 5km distance from the release sites and later on they settle on two different locations.

Barman *et al.* (2014) documented rehabilitated female behaviour at Manas NP. Their study revealed that rehabilitated rhinos can successfully adapt after reintroduction.

Dutta and Mahanta (2015) studied behaviour and colonization of translocated rhinos for the first 90 days of release at MNP. Dutta *et al.* (2017) studied post-release behaviour of 10 greater one-horned rhinoceros' (*Rhinoceros unicornis*) translocated to Manas National

Park, Assam, India was carried out to understand how each individual rhino behaves in a new environment.

Ecological studies on Rhinos

Different researchers studied and reported various accounts on habitat and ecology of Indian rhinos since the past. Gee (1953a, 1964) mentioned rhinos habitats and ecology in KNP and Chitwan. He described both protected areas had excellent habitat composition for rhinos. He mentioned the aquatic habitat degradation due to rapid propagation of water hyacinth in Kaziranga.

Avari (1957) studied about habitat situation of Jaldapara in fifties decades of last century. He reported suitable rhinos' habitat at Jaldapara with mixed vegetations including several low lying isolated swamps. He also suggested better management of habitat to increase the productivity of rhinoceros populations.

Burnett (1958) mentioned that Manas possesses few perennial waterholes which directly influenced the rhinos' population growth. Therefore, he urged park management to create favourable habitat condition for betterment of rhinos.

Stracey (1963) indicated the ecological management of rhino habitats and provided implications for better management of grassland habitats in KNP. He mentioned that use of fire to hold the ecological succession of the grass stage is obligatory at KNP.

Lahan and Sonowal (1973) documented habitat preferences of rhinos in KNP and provide a necessary suggestion for improvement during monsoon and dry period. They found that KNP rhinos preferred open and short grassland for most of the time. So, they suggested annual control burning to reduce the density of thick and tall grassland areas. They also mentioned flood is essential for maintaining the habitat of KNP but river erosion has greatly reduced the areas of the park.

Lahan (1974) again studied biotic and edaphic factors influences on rhinoceros population of KNP. He observed that annual control grassland burning and annual flood is essential to maintain habitat of Kaziranga. But river erosion, an increase of water hyacinth in water bodies, invasion of weed like Mikania in grassland habitat, disease and poaching are some major threats to the future survival of rhino at KNP.

Laurie (1978) documented the habitat preferences of rhinos in respect to different seasons in Chitwan NP. He found that rhinos in Chitwan reach their highest densities in areas with greatest vegetation diversity.

Following Laurie's studies, some good research work were undertaken by several researchers in Chitwan NP. Dinerstein (1979a) has studied ecological aspects of Royal Karnali-Bardia Wildlife Reserve (Present Bardia NP) and habitat interaction.

Blanford and Price (1991) and Dinerstein and Price (1991) studied demography and habitat used by Rhinos in Chitwan Valley. They have studied from the period of 1984 to 1988 in Chitwan and observed rhino population pattern and influences of habitat on their population growth.

Ghose (1991) studied eco-status of rhinos with special reference to altered habitat due to human interference in

Jaldapara WLS (now National Park). Dinerstein (1992) again studied the effect of rhinos on riverine forest structure in Lowland Nepal. Purpose of his study was to elucidate how large mammalian herbivores (rhino and elephant) influences forest structure and canopy composition by the vertical growth of sapling that is frequently browsed and trampled.

Bist (1994) studied rhino range areas habitat status and entire wild rhino population of West Bengal. He reported that gradual loss of rhino habitat was due to the extension of agriculture and establishment of tea gardens, encroachment in rhino habitat due to the influx of refugee from Bangladesh, river erosion due to five fast flowing river traversing into North Bengal and improper forestry practices.

Barua (1998) mentioned about rhino habitat degradation of PWS due to annual flood, invasion of invasive species like *Albezzia procera* in grassland and cattle grazing. Kushwaha *et al.* (2000) studied the land area change and rhino habitat suitability in KNP. They found that KNP is by and large suitable for rhinos and identified 27% of park areas was unsuitable for rhinos. Banerjee *et al.* (2001) studied habitat used by rhinos and other sympatric herbivores in KNP and provided scientific insight to manage habitat and herbivore population.

Kandel (2003) studied rhinos' foraging activity in correlation with different habitats of Chitwan NP. He observed that maximum proportion of time spent feeding was in the grassland followed riverine mixed forest in the ecotone. Rhinos used riverine mixed forest a lot for resting during afternoon hours.

Dinerstein (2003) reported home range changes of adult males and adult females in relation to different seasons at Chitwan NP. He observed that annual home range of adult males were larger than that of adult females.

Rawat (2005) critically analysed vegetation of rhinoceros at North Bengal. He reported that continuous intervention necessary to check weed invasion in rhino preferred grassland and water bodies. He urged long term monitoring of vegetation/habitat and water courses with the support of remote sensing technology for future predict of rhino habitat trend.

Bairagee *et al.* (2003) reported dominant tall grassland species influences on rhinoceros habitats at PWS. According to this study, grass species *Imperata cylindrica* is significantly dominant in disturbed and managed areas. But in unmanaged and undisturbed areas, the growth pattern of this species was observed to be slower and assemblages pattern of species was dominated by other grass species along with forbes.

Kandel and Jhala (2008) studied eight free ranging rhinos habitat preferences at Chitwan NP and they observed that rhinos used grasslands, riverine mixed forest, and ecotones and were not observed to use Sal forest.

The study by Agarwal *et al.* (2010) was aimed to identify suitable habitat area for rhinoceros using the geo-spatial tool. They used seven variables *i.e.* road network, railway network, national highway, digital elevation model (DEM), land use land cover (LULC), settlement and protected area as important factors in determining the rhino's habitat area.

Hazarika and Saikia (2011) studied rhinos' habitat utilization and seasonal ranging pattern of RGONP. They observed that the rhinos preferred different habitat as per season. Bailey (2011) studied seasonal changes of habitat condition and ranging pattern of rhinos at Chitwan NP. He designed his study with the support of econometric model to understand rhinos crop damage pattern in fringe village areas and villagers' responses on such incidence.

Bhatta (2011) studied ecological aspects of PWS rhinos and mentioned the seasonal ranging pattern of male and female. He reported the habitat of Pobitora degraded due to improper management, and numerous anthropogenic pressure. The study revealed that park management control was mainly protection based and less priority were given to habitat management.

Lahkar *et al.* (2011) indicated invasion of alien plant and other habitat degraded factors in rhino ranging areas. Following them, Subedi (2012) studied invasive species' impacts on rhinos habitat in Chitwan NP. He reported the influence of seasonal variations in habitat preferences. He found three to six folds increment in home range sizes in Chitwan rhinos compared to previous studies which may be attributed to habitat degradation due to the invasion of invasive species, plant succession and low-density rhino population.

Sarma *et al.* (2012) studied rhinoceros habitat utilization pattern considering hydrology, flood impact and spread of invasive species mimosa at RGONP. They found that rhinos used wet alluvial grassland in all round the years. They also reported that habitat utilization pattern of rhinoceros is dependent upon food, grass cover, and water.

Thapa *et al.* (2014) used geographical information system (GIS) and remote sensing to build habitat suitability model for the rhinos and provided management implications to Chitwan NP. They suggested that several variables such as land cover types, water availability, topography, altitude, human activities and their impact on species and habitat are significant in predicting suitable habitat for rhinoceros.

Ecological studies on translocated Rhinos

Jnawali (1995) studied population ecology of translocated rhinos at Bardia NP and emphasised on habitat preferences, ranging behaviour and food ecology. He reported average larger home range size of rhinoceros at Bardia then the donor population (Chitwan rhinos). He also observed seasonal home range size varied 13.3km² to 21.2km² which was >8 times larger than donor population. This finding attributed to low rhinoceros density and sex ratio at Bardia NP.

Jnawali and Wegge (1995) worked on nine radio-collared rhinos habitats use and speciation pattern which was similar to earlier works by Jnawali (1995). Fjellstad and Steinheim (1996) compared rhinos and elephants' habitat preferences in Babai Valley Bardia NP. They stated that rhinos and elephants both preferred tall grass flood plain and Khair-Sisoo forest. An elephant usually prefers savannah woodland whereas rhino prefers moist riverine forest. Steinheim *et al.* (2005) worked on dry season habitat use of rhinoceros at Bardia NP. They also studied

how rhinoceros and sympatric species of elephants shared their space in the same habitat.

Patar *et al.* (2007) studied on habitat suitability for rhino at MNP before translocation. They have indicated suitable habitat prevail in Manas for the rhino reintroduction. They suggested scientific management of grassland habitat and water bodies for better productivity species. Bezbaruwa (2008) conducted the study at Manas with the support of earlier research, base map, satellite imagery and ground survey before rhino translocation.

Thapa *et al.* (2009) conducted a study on habitat preferences of translocated rhinos in Bardia NP and Shuklaphanta WLS based on direct observation and survey on rhino sign from the period of 2003-2005. They found that rhinos were used grassland intermixed with wetlands and riverine forests. Dutta *et al.* (2012) studied habitat preferences of rhinoceros at MNP and they found considerable grassland habitat preferences on rhinoceros.

Tripathi (2012) studied ecological requirements of rhino enclosure areas from January to December 2011 in Dudhwa NP and subsequently provided habitat management recommendations for better productivity of rhino stocking areas. He reported that water bodies were heavily silted and therefore suggested to prepare more perennial water sources for better productivity of habitat.

Dutta and Mahanta (2015) studied colonization as well as give light on association pattern of translocated rhinos first 90 days of release at MNP and this was one kind of study yet to carry out on greater one horned rhinos.

Discussion

Behavioural and ecological studies are important to understand overall conservation of rhinoceros. In this context, comparatively less studies undertaken on general rhino bearing areas. There is much more research necessary to understand conservation benefit of rhinos both general and reintroduced populations.

To develop a rhino metapopulation dynamics and to predict population in new areas ranging behaviour and dispersal pattern are essential on donor and recipient sites. But there are comparatively less studies on this aspects. There is utmost need to study the impact of behaviour activity in respect to different habitat including food preferences and nutrient quality. But which was seen less in respect of general rhino and translocated rhino population.

In respect to behavioural responses of anthropogenic disturbance due to tourism, traffic and even from respective protected areas different conservation management programs effect the rhino's behaviour and ecological changes yet to get much attraction.

Disease has potentially distressing consequences and it can alter large or small populations of wild animal to a few individuals, leaving them vulnerable to other forms of stochasticity in respect to particular habitat and their association behaviour (Caro, 1999). Disease may influence the dispersal behaviour of wild animal from one patches to others but there less attention on research observed on rhino both in general and translocated populations.

The number of male female ratio of rhinos and the presence dominant bull strongly influenced the mating behaviour as well as population size and age structure which is yet to get much attention as research. There are research gaps in responses on rhino behaviour on exploitation and disturbance, captive breeding and rehabilitated stocks of rhinos' release in wild and post release behaviour in new habitat. There is much research attention required in productivity of different rhino habitat in relation to population growth of each respective area.

Conclusion

Though there are limited studies on rhino's behaviour and ecological aspects but these studies have supported much on conservation of rhinos in wild and also helping translocation and reintroduction process. But extensive research is necessary on these subjects based on empirical data, formal models with relevant research topic. These research work need more people at the interface so that it can be helpful to impress conservation managers for implementation and finally survival of species.

वन्य से वन्य स्थानान्तरित गैंडे के विशेष संदर्भ के साथ वृहत् एक सिंगदार गैंडे के व्यवहार एवं पारिस्थितिकी पर अध्ययन:

एक पुनरीक्षण

देबा कुमार दत्ता एवं रीता महन्ता

सारांश

वृहद् एक सिंगदार गैंडे की व्यवहार एवं पारिस्थितिकी पशु की उत्तरजीवित्ता के समझने के लिए सबसे महत्वपूर्ण विषय में से एक है। पशु के व्यावहारिक एवं पारिस्थितिकीय पहलुओं पर बहुत सीमित अध्ययन हैं। इस अध्ययन में वन्य में तथा पुनरसूत्रपात की प्रक्रिया के दौरान गैंडे के सामान्य व्यवहार तथा पारिस्थितिकीय अध्ययन की मुख्य-मुख्य बातें बताई गई हैं। चूंकि भारत और नेपाल में गत कुछ दशकों में सीमित गैंडे की स्थानान्तरण प्रक्रिया की गई, इसलिए इन पहलुओं में अनुसंधान की न्यूनतम गुंजाइश थी। स्थानान्तरित गैंडा व्यवहार एवं पारिस्थितिकीय भारत और नेपाल के विभिन्न गैंडा धारित क्षेत्रों के पूर्व में सम्पादित वन्य गैंडा अध्ययनों पर आधारित हैं। इस अध्ययन में वन्य एवं पुनरसूत्रपात किए गए गैंडा व्यवहार तथा पारिस्थितिकी दोनों भागों की मुख्य-मुख्य बातें बताई गई हैं क्योंकि गैंडा रेजिंग इलाकों के दाता एवं प्रापक स्थलों में प्रजाति की सुरक्षा एवं परिरक्षण के लिए ये दो अहम पहलु हैं।

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