

**FINAL TECHNICAL REPORT  
2008**

**ONE HORNED RHINOCEROS CONSERVATION IN  
MANAS TIGER RESERVE**

**Principal Investigator: Dr. Pranjal Bezbarua**



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species**

Final Technical Report  
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MANAS TIGER RESERVE*

Principal Investigator: Dr. Pranjal Bezbarua

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## *Preface*

Assam forest department has started a mega programme on greater one horned rhinoceros conservation in Assam with support of different local, national and international organization. The programme which started in July 2005 and globally known as Indian Rhino Vision-2020 aims to increase the rhino population from 2000 to 3000 numbers at the end of 2020 by translocation and increasing security scenario to the species. Initiative was taken to involve all the stakeholders working for rhinoceros conservation under one umbrella. As the programme selected Manas tiger reserve- a former rhino habitat as first choice of translocation site, different types of short term and long term strategies were needed. Being a partner of Indian Rhino Vision-2020 and our involvement as a researcher and conservation worker in Manas tiger reserve since 2000, we also involved in the campaign to raise fund for the work. It is nice to see that Peoples' Trust for Endangered Species of Great Britain came forward to support our programme. Several sad incidents like death of International Rhino Foundation (IRF) officials that include Dr. Thomas J. Foose and Dr. Nico Van Strein and other conservationists involved in Indian Rhino Vision-2020 and constrains in the ground delayed the programme. Although we started our works in 2006 after PTES agreed to support, the fund could not be transferred due to some technical problem and project work suffered. We received the PTES fund on March 2007 from Dr. Nico Van Strein of IRF which helped to continue the work smoothly. Although we could not get the initial matching fund for the work due to some technical problem, Dr. Sussie Eleis of IRF helped and recommended to get other grants to continue the rhino conservation work.

## Acknowledgement

I would like to thank Peoples' Trust for Endangered Species of UK for the financial support of the project. I also express my sincere gratitude to former Director Late Dr. Thomas J. Foose of International Rhino Foundation (IRF) for his personal initiative in transferring the PTES grant which was later personally handed over by Late Dr. Nico Van Strein of IRF to Grasshopper in Guwahati, India. I would also like to thank Dr. Susie Elies of IRF for her help to get matching grant from other organization to continue the rhino conservation work. Dr. Cathy Dean of EAZA rhino campaign initiated to introduce our work with IRF before starting of the Indian Rhino conservation programme. Prof. C.K. Baruah and Dr. G.C. Sarma of Botany department, Gauhati University helped us at different periods including identification of problematic plant species. Special thanks goes to my colleague Dr. Buddhin Hazarika for the part of study carried out on rhino habitat use and food plants in Orang national work. This information helps us to compare with the data on Manas to design habitat suitability model. I would like to thank Mr. N. Bhagoboti of IASST, Guwahati and Mr. Prasanna Baruah of ARSEC, Guwahati for their help in data analysis and map preparation respectively. I also would like to thank the local forest authority for the necessary permission and infrastructural facilities. I specially like to mention the help by the present field director A. Sargiary, deputy field director, C.R. Bhabora, past field director A. Rabha, range officers M. Brahma, L. Ramchiary and front line forest staffs. I also extend my gratitude to different local conservation groups namely Manas Maozigendri Ecotourism Society, Manas Souci Konkhor Ecotourism Society under NGO (Prateedhani), Agrang Ecotourism Society, Bhuyanpara Ecotourism Society, Manas Ever Welfare Society, Panbari Manas National Park Protection & Ecotourism Society, Raiguli Ecotourism Society, Green Manas during the project period. Besides different officials of organization like Aranyak, WTI and WWF extended cooperation during the project period. I would like to specially mention the support provided by conservation volunteers, village heads, local Bodo leaders, teachers and students and villagers of the area. I would like to extend my gratitude to members of Grasshopper and my family for their kind support during the project period.

## Executive summary

The Indian one horned rhinoceros, having a global population of 2400 has been facing increasing threat from organized poaching and habitat loss. Despite 100 years of success in conservation of rhino in Kaziranga National Park (NP), the endangered species was locally eliminated in protected areas namely Laokhowa, Burachapari, Kochmara, Kurua and Manas tiger reserve of Assam, India. Besides threats of stochastic risk of rhinos in Kaziranga NP and Pabitora wildlife sanctuary, increasing man-rhino conflict; continuing poaching in the all three rhino areas having a population about 2000 was a cause of concern. Therefore, the forest department with support of all stakeholders designed a 15 years rhino conservation programme that focused overall increasing security and rhino translocation to increase the population from 2000 to 3000 which will be distributed in six protected areas. Being a partner to this mega programme known as Indian Rhino Vision 2020, Grasshopper started a programme in Manas tiger reserve a former rhino habitat selected for rhino translocation. The programme aims to study the habitat suitability of the one horned rhinoceros in Manas tiger reserve, to rehabilitate ex-poachers/forest dependent cum conservation workers of the area and conservation education and capacity building in fringe villages of the reserve.

Remote sensing technique and GIS was used to generate maps considering all ground information like former rhino habitat in grassland and forests communities of Manas, aquatic bodies, topography, different anthropogenic factors namely past and present poaching threats, encroachment, weed invasion, grazing pressure from domestic cattle, burning intensity; awareness level in fringe villages, departmental infrastructure etc. The information helped in preparation of final map on rhino habitat suitability indicating most suitable (23.48%), suitable (46.33%), less suitable (24.16%) and unsuitable zone (6.02%) in Manas tiger reserve. Though, most suitable and suitable habitat still exists in western and Manas river ecosystem, the poaching threat scenario converted it to less suitable zone. The result confirmed the richness of rhino habitat in terms of diverse grassland associations and food plants. Of course the presence of different anthropogenic pressure caused degradation of habitat in southern zone of the reserve.

The rehabilitation programme on families of selected conservation volunteers ( that included surrendered ex-poachers also) and forest dependent was started with introduction of capacity building on alternative livelihood on agro and veterinary products that varies from piggeries, zinger and citrus cultivation, vermi-compost, small business, bee keeping etc. Small in kind support was provided to the beneficiaries who formed self help groups having 10 members. Professional experts, government departments and local NGOs were helping us in these efforts. The first thing, we observed was gradual

behavior change in terms of growing interest and confidence building which helped in achieving 50-70 percent success amongst different SHGs in next phases. They raised money amongst themselves to continue the work as well as lending it amongst themselves and others. More groups were coming to replicate this type of microfinance system. We also provided school bags and education material amongst the children of poor conservation volunteers and forest dependents. It is nice to see that the students (vulnerable to become future poachers) continuing school and a few of them secured top position in examination.

Awareness and capacity building on rhino conservation was initiated with preparing a conservation leaflet in local language that was used in all conservation meetings, distributed amongst all local conservation groups, teachers and students, forest staffs and other stakeholders. The material helped several local NGOs and ground staffs to understand the mission of Indian Rhino Vision 2020 programme and need of the rhino conservation. We also focused on alternative livelihood generation programme to encourage the villagers of the fringe areas.

We did some additional works during the project period. The PTES support in the programme helped to raise other fund to continue the work. We voluntarily helped local NGO in their ecotourism campaign and good amount of money was raised from the last PTES trip to Assam in January, 2009 to supply ration for 80 conservation volunteers patrolling the Manas biosphere reserve during critical period. Project proposals were also written by us for local NGOs so that they could submit it directly to different agencies. We also monitored the translocated rhino strayed to villages and helped forest official during the crisis. Threat to rhino habitat like flood in 2007 due to excess release of water by dam in Bhutan, weed invasion were also reported to members of rhino specialist group and other international stakeholders involved in Indian Rhino Vision-2020 programme. We assisted visiting UNESCO mission to evaluate the overall perspective of Manas world Heritage (in danger) site. It is nice to see that the degraded rhino habitat has been restoring gradually due to hard work of forest department and local communities.

The project recommended continuing community conservation programme to develop rural economy of the fringe villages of the Manas tiger reserve and restoring degraded habitat and population (continue rhino translocation as planned and modified by the taskforce of IRV-2020), encouraging rhino research in gap areas, presence of well equipped trained front line staff and welfare schemes for them, increasing support in restoring rhino habitat in buffer zone also, better coordination amongst all stakeholders and strict vigilance on threats like movement of wildlife traders and forest mafias, involving biologist in habitat management, opening of blocked channel of Manas river including monitoring flood and dams in Bhutan.



## Introduction

The Great Indian one horned rhinoceros: *Rhinoceros unicornis* Linnaeus 1758 has been facing great threat due to continuous organized poaching particularly for its horn and habitat shrinkage through different kinds of anthropogenic activities. During 2005, the global population of Indian rhino was estimated to be 2400 where about 2000 numbers were distributed in Assam. Kaziranga National Park (NP) shares about 93 percent of rhinos in Assam and 75 percent of global population. This can be regarded as a great success to the park as starting from a dozen of rhinos in 1905, the population lies at 1800 in hundred years through increasing security scenario. Besides Kaziranga National Park, Pabitora Wildlife Sanctuary (WLS) and Orang National Park have good number of rhinos due to constant security. Unfortunately despite 100 years of success in conservation history for rhino in Assam, the species was eliminated from other rhino habitat of the state namely Laokhowa WLS, Burachapari WLS, Kurua zone and Manas Tiger Reserve. In Manas, almost all 100 rhinos were eliminated during the political unrest period 1989-2001. In Nepal also, there has been a dramatic decline in numbers (544 to 360) of rhino in Royal Chitwan NP (second largest population of the species on the planet) as a result of the Maoist insurgency in that country. Restriction of about 85% of the rhinos to a single protected area like Kaziranga exposes the species to stochastic risks. There are currently only 9 breeding populations of *R. unicornis* in 2 countries. Moreover, only two of the *R. unicornis* populations (Kaziranga and Chitwan National Park in Nepal) have more than 100 individuals. The population in Pabitora wild life sanctuary has already exceeded the carrying capacity and the population needs to be reduced both to protect the habitat and to mitigate the increasing rhino-human conflicts occurring as animals move out of the park into agricultural areas. Therefore there is a need of long term practical management plan to find a solution to the threat to the rhino in Assam that share major population in the region.

As a consequence, the Assam Forest Department and the various NGOs and institutes interested and involved in conservation of *Rhinoceros unicornis* have agreed that range expansion of the rhino in Assam through translocations from Kaziranga and Pabitora to other appropriate protected areas is a prudent direction for future efforts. Such translocations have produced initial positive results in Nepal for *Rhinoceros unicornis* and longer term success in Africa for southern white rhino (Foose, pers comm. 2005).

This programme in Assam is globally known as Indian Rhino Vision-2020 where by

rhino translocation and increasing security the population will be increased to 3000 from 2000 as well as to expand the distribution in at least 6 protected areas in 15 years period. To achieve the goal, there is a need to find suitable rhino habitats as well as increasing security through all means. The core of Manas tiger reserve (also adorned as Manas National Park) has been selected for the programme at first step being a former rhino habitat and has some hope of possibility of better security due to strong initiative taken by local conservation groups and forest department where hardcore poachers surrendered and turned to hardcore forest protectors. Though Manas was a former rhino habitat, it was not known scientifically the habitat suitability of the area at present time. The park will receive 20-30 rhinos from Kaziranga and Pabitora both situated in floodplain of Brahmaputra river whereas Manas is comparatively dry and located in high altitude bhabor terai zone in Indo-Bhutan border area (Bezbarua, 2007). There is very limited published literature on detail habitat suitability study of Indian rhinos. Most of the earlier publications were based on observations made by sportsmen or naturalists. Gee (1953,1959,1963) conducted a survey on rhinos in Kaziranga NP and in Royal Chitwan NP addressing the ecology and behaviour of rhinos. Laurie (1978) and Dinerstein (1979) conducted landmark studies on the ecology of herbivores in the terai grasslands of Nepal. Laurie (1978) found much seasonal variation in the food availability and the resultant movement of rhinos between different habitat types. Rhinos were observed feeding on abundant fibrous food supplemented by a wide variety of other plants. Grasses constituted 70-89% of their diet according to the season in Royal Chitwan NP (Laurie 1978). Jnawali (1995) also confirmed the diverse diet of the rhinoceros with more than 60% of their diet being constituted of grasses. More recent studies addressing the ecology of the species includes the work by Dinerstein and Price (1991) on the demography and habitat use by rhino in Royal Chitwan NP. Sinha and Sawarkar (1993) studied the habitat use and seasonal variation in the range of movement in a case of reintroduced rhinos in Dudhwa NP, India. Jnawali and Wegge (1993) looked at the space and habitat use by the reintroduced rhino population in Royal Bardia NP in Nepal. Karki et al. (2000) looked at the effects of grazing and management intervention in Royal Bardia NP and concluded that ungulate concentration in habitat patches leads to the formation of grazing lawns that are characterized by growth of very short grasses differing in composition from the neighboring areas. These patches recovered once grazing pressures declined. Ghosh (1997) looked at the effect of fire in the chauris of Corbett NP. Biswas (1999) looked at the habitat use by hog deer including sympatric species such as rhinos in the Duar grasslands of Jaldapara WLS across areas of natural grasslands and managed grasslands. With initiation of Indian Rhino Vision-2020, the different

stakeholders of the programme including GRASSHOPPER did some rapid survey through remote sensing technique on rhino habitat which needs to be extended to microhabitat level considering all natural and anthropogenic factors. The grassland and forest dynamics model of Manas biosphere reserve (Bezbarua, 2007) indicated some vital information about the richness of habitat. The overall review of literature reveals that the rhino habitat suitability studies in Assam particularly in Manas have received scant attention. Therefore, the habitat suitability study at microhabitat level is very much important for the survival of the translocated rhinos and become a breeding population in the Manas tiger reserve.

Secondly for better protection of the species, it is also important to increase the level of involvement of local community and groups through conservation education. Despite being well protected, poaching continue in all the exiting rhino protected areas including Kaziranga. Presently, the international wildlife traders has built a better network with local poachers and anti-social elements and using most sophisticated methods to carry out operation. The absence or poor community participation may lead to local elimination of wildlife like rhino. Thirdly, rehabilitation of families of surrendered poachers now turned forest protectors of Manas is an urgent need through alternative livelihood to minimize the threats of their return to old profession. In past, we noticed how surrendered poachers again had returned to their old profession due to lack of rehabilitation. The children of the area particularly from these poor families and neighborhood have also a tendency to become poachers due to poor awareness and lack of school education.

Considering the above scenario and being a partner in the Indian Rhino Vision 2020 GRASSHOPPER developed this project to support the overall mega programme with the financial support of Peoples' Trust for Endangered Species, UK.

## **Aims and Objectives**

The aim is to find the rhino habitat suitability status and strengthening greater community participation in rhino conservation in Manas tiger reserve. Detail project objectives are as follows:

1. To study the habitat suitability of the one horned rhinoceros in Manas tiger reserve
2. To rehabilitate ex-poachers/forest dependent cum conservation workers
3. Conservation education and capacity building in fringe villages of rhino habitat

## Methodology

With support of the base map (satellite imageries IRS LISS III, 2006 and topomaps of survey of India scale 1: 50000) ground survey was conducted using GPS (Magellan model) to verify the land use cover of the area and locating past rhino distribution. We randomly placed 26 belt transects of length 500 meters each having 10 quadrats of size 1mX1m in the grassland. In forest, 8 belt transects were placed with 10 numbers of quadrats in each of them and size 10mX10m for tree species. Nested quadrats of size 2mX 2m were also placed for undergrowth vegetation. Data on cover of grass and non grass species in grassland areas and number and basal area for trees and undergrowth species in the forest were collected. Data on threats like grassland invasive species, human entry routes, illegal burning, and resource collection including poaching threat were also recorded. A key was prepared to categorise suitability criteria of rhino habitat. It covered type of vegetation characteristics at micro level, availability of water bodies, nearby forest cover and its undergrowth vegetation, food plants availability all type of threat perspective like habitat disturbance and poaching aspect that also linked present infrastructure and antipoaching measures, awareness level and socio-economic-political situation in fringe villages.

**Table1: Rule for designing Rhino habitat Suitability in Manas Tiger Reserve**

Suitability category	Soil	Distance from aquatic bodies in meters		Grassland species type	Distance of Forest near grassland in meters	Biotic Pressure			Poaching Threat
		Grass area	Forest area			Weed invasion	Grassland Burning*	Resource collection	
<b>Most suitable</b>	wet sandy-loam & mud	0-1000	0-500	Wet & lowland	0-500	0	41-60%	0	0
<b>Suitable</b>	river sand	1001-2000	501-1200	semi wet	501-1000	0.1-20%	30-40%, 61-70%	0.1-5%	Low
<b>less Suitable</b>	river rock	2001-10000	1201-10000	upland dry	1001-7000	21-80%	1-29%, 71-80%	6-30%	Moderate
<b>Unsuitable</b>	dry rock	Above 10000	Above 10000	Degraded or Human habitation	Above 7000	>80%	>80%	>30%	High

\*The burning percentage is applicable on those dry sites prone to annual severe burning, lack of mosaic burning, heavy fuel load due to lack of burning for three years. It is not applicable for wetland or wet grass community having perennial water source. The wet grass community may not be burnt for several years yet fuel load is minimized due to water logging condition to encourage microbial decomposition and deposition of silt in the base of the grass and naturally managed.

The data was analysed through biological software TWINSPAN (version 2.3, 2005) and R-console (Oksanen, 2006) to find out the grassland associations at microhabitat level. For forest community, importance value index (Mishra, 1968) of the species was considered to assess habitat

characteristics. We modified the methods of Kushwaha et al. (2000) to generate a habitat suitability map with support of GIS software Arc/Info version 9.1. Presence of plant associations in preferred rhino habitat of Orang (Hazarika, 2007), Kaziranga (Baruah, 1998) and former rhino areas of Manas were considered in spatial interpolation of geospatial field data to improve the design of the suitability model.

Free training sessions were arranged on available agro-veterinary resources to promote alternative livelihood of families of ex-poacher turned conservation volunteers and forest dependents. This was followed by in kind support to beneficiaries to start their work in a joint effort manner by formation of self help groups. Time to time monitoring, counselling was done by local NGOs and project personnel to assess the development.

To promote education, school kits were provided to the children of selected ex poacher turned conservation volunteers and forest dependents. We requested the school administrations through our local partners to take care of these children to get proper education.

Rhino education material was prepared in local language. Different information resulted from literature and ongoing research on rhino was incorporated in the preparation of the education material in simple language to reach all section of mass. The material included information about the importance of rhinos and their ecological services as well as about Indian Rhino Vision-2020. Local NGOs & groups working in core of the tiger reserve and adjacent buffer including school teachers and student groups, local personalities, village heads were involved in organizing public meetings targeting sensitive villages. We distributed the conservation material to the participants of the awareness meetings. The benefits of rhino conservation as well as biodiversity conservation, local example of ecological boomerang and ecological services including eco-developmental works and scope of ecotourism were discussed to aware the local people and appeal to the mass to involve in the conservation and protection of rhinos. The design of discussion was thoroughly demonstrated before the local NGOs and other stakeholders as well as free distribution of rhino education material as part of the capacity building activities.

## Study Site

Manas tiger reserve, comprising an area of 2837.12 sq. km. is situated in the foothills of Himalayas, flanked by Indo-Bhutan international boundary in the north and more than 200 fringe villages of different tribal and plain communities of Assam in the south. The western boundary extends to river Sonkosh, adjacent to Buxa tiger reserve of West Bengal; while the eastern boundary is marked by Dhansiri river of Udalguri district of Assam. Geographically the area is located in between 89°51'45"E-92°07'00"E longitude and 26°30'00" N-26°56'43"N latitude and altitude

ranging between 40-720 meters from mean sea level. The core zone of Manas tiger reserve having an area of 519.77 sq. km. and lies in between 90°48'00"E-91°15'00"E longitude and 26°36'00"N-26°49'00" latitude was selected for habitat suitability study. Of course, apart from adjacent village of the core zone, the community conservation works was extended to near by buffer villages. The climate of the tiger reserve was found to be subtropical in nature, with temperature lies in between 6°-37° Celsius. The coolest period was from late December to early January while hottest season was recorded in the month of May. The average annual rainfall lies in between 3000 mm-4000 mm, attaining peak during the month of July and August that often causes flash flood for brief period. The driest period of the season was in between late February to early March. The topography of the Manas tiger reserve is a flat plain with gently slopes towards southern areas in core zone while some undulating hilly areas at the Indo-Bhutan border led to different kinds of ecosystem formation. There is a well-marked bhabor tract of rocky soil towards the northern boundary that contains sandstone, limestone and shale having very little moisture retaining capacity. The bhabor tract generally remains dry and is characterized by maximum relief, dissection and drainage density amongst all the major streams in this area and is deeply entrenched within it. The flood plains abut against the dissected mountain front of the sub Himalayas. The streams and rivers that become turbulent in the rainy season frequently flood the riparian areas. Apart from bifurcating Manas river in Indo-Bhutan border, the core area also comprised of streams like Sukhanjan in west border, Burisuti, Gabharukhonda, Jongrong-Songrong Gyati, Pahumara, Garusora, Rabang, Suti Rabang Doimari, Teklai, Tangunmara, Jia simbu, Mora simbu, Kalpani, Sikari, Madulijora, Sarphuli and Pota at the eastern boundary. These streams and rivers are running through the reserve, carry enormous amount of silt and rock from the foothills resulting in the development of alluvial terraces comprising of thick deposits of mineral particles and detritus overlain with sand and soil of varying depth with shifting river channels and swamps. Highly porous bhabor formation in the northern part as well as terai tract and fine alluvial deposits with underlying pans in the southern parts is typical of the reserve. Except for a few perennial rivers/streams most of the other smaller and shallow water bodies or streams become dry during winter months. This bhabor-terai zone shows characters of dryness of most of the streams even in monsoon period and formation of natural springs in the southern side of the reserve. Of course during rains, there are flows of high speed water through these natural drainages for short period. Besides there are number of standing water bodies, locally known as 'beels' which act as reservoirs for extensive rainy water during monsoon. Most of the water bodies were created by the changing of the river and streams and blockade of the channels. Besides, several small ponds were created by the management authority in different parts of the reserve.

## Results & Discussion

### Habitat suitability of Rhino in Manas Tiger Reserve

The remote sensing satellite imagery based map generated from the study has indicated the presence of all types of plant communities namely tall and short grassland ( 37.19% ), evergreen and semi-evergreen forest (0.18% ), mixed moist dense and open deciduous forest ( 47.34%), water bodies like perennial river, streams, pond and beels (4.41%), dry river (4.08%), river sand (4.202%). The investigation observed that 3.725% area is under encroachment covering two zones in Panbari and Bhuyanpara range.

The study identified nine grassland assemblages or associations in rhino habitat namely *Phragmites karka* – *Themeda villosa* - *Saccharum ravennae*, *Arundo donox*, *Saccharum ravennae*, *Phragmites karka* – *Saccharum spontaneum* – *Saccharum ravennae*- *Saccharum narenga* , *Phragmites karka*, *Imperata cylindrica*, *Imperata cylindrica*-*Saccharum narenga*, *Saccharum narenga*, *Saccharum spontaneum* and one non grass assemblage *Alpinia allughas*. The investigation showed that the grassland assemblages were distributed in diverse altitude ranging from 50 meters in southern boundary to 280 meters in northern upland. Well developed upland grassland are covered by *Imperata cylindrica* and *Saccharum narenga* based associations where as preferred rhino habitats in the low lying grassland are comprised of associations dominated by *Phragmites karka*, *Themeda villosa*, *Saccharum ravennae*, *Arundo donox* and *Alpinia allughas* type species. Riparian grassland is mainly covered by *Saccharum spontaneum*. The majority of rhino populations were distributed mainly in the eastern part i.e Bhuyanpara range dominated by low-lying tall grassland assemblage having a height of 3-4.5 meters comprised of *Phragmites karka*, *Phragmites-Themeda villosa*-*Saccharum ravennae*, *Phragmites-Themeda villosa*-*Alpinia allughas*, *Arundo donox* and *Saccharum spontaneum* including pure *Alpinia* patch, swampy forest and wetlands located in remote forest areas.

Although one horned rhinoceros prefer grassland community, it also used forest patch for cover to get rid of hot sun, using aquatic bodies of the forest as preferred wallowing during summer and for undergrowth food plants. Sometimes it consumes fruit even leaves of young trees. In Manas the evergreen forest is comprised of *Michelia champaca*, *Dysoxylum binectariferum*, *Aphanomixis polystachya*, *Premna bengalensis*, *Premna latifolia* along with moderate to low population of *Cinnamomum tamala*, *Madhuka longifolia*, *Morus laviogata*, *Eriobotrya bengalensis*, *Mangifera sylvatica*, *Artocarpus chaplasha*, *Spondius axillaries*. The semievergreen forest is dominated mainly by *Aphanomixis polystachya*, *Anthocephalus chinensis*, *Lagerstroemia parviflora*, *Dysoxylum binectariferum*, *Stereospermum chelonoides*, *Trewia nodiflora*, *Syzygium cumini*, *Syzygium formosum*, *Michelia champaca*, *Bauhinia*

*purpurea*, *Mallotus philippensis*, *Careya arborea*, *Toona ciliata*, *Bombax ceiba*. The mixed deciduous forest is covered by *Lagerstroemia parviflora*, *Dillenia pentagyna*, *Bombax ceiba*, *Careya arborea* along with moderately grown *Trewia nodiflora*, *Bridellia retusa*, *Hollarhena antidysenterica*, *Lagerstroemia parviflora*, *Terminalia bellerica*, *Terminalia chebula*, *Toona ciliata*, *Sterculia villosa*, *Oroxylum indicum*, *Albizzia procera*, *Albizzia lebeck*, *Bischofia javanica*, *Gmelina arborea*. The riparian bed is also covered by *Bombax ceiba* and *Dalbergia sissoo* assemblage.

The undergrowth forest community of Manas is mainly comprised of sciophytic species like *Phlogocanthus thyrsoiflorus*, *Litsea salicifolia*, *Adhotoda vasica*, *Piper mullesua*, *Mimosa himalayana*, *Murraya koenigii*, *Clerodendron viscosum*, *Glycosmis arborea*, *Costus speciosa*, *Blacknum orientale*, *Piper diffusum*, *Zingiber zerumbet*, *Setaria pallida* in the moist forest. The forest floor of the dry deciduous and disturbed forest was covered by mainly heliophytes like *Chromaelaena odorata*, *Leea asiatica*, *Ageratum conyzoids*, *Tephrosia candida*, *Crotolaria sissilifera* etc. The forest floor with high moisture content when opened by moderate logging pressure was quickly covered by fern *Dryopteris palaecea*. On the other hand, the swampy forest floor is mainly covered by cane like *Calamus floribundus* as well as wetland non grass *Alpinia allughas*. The presence of grass *Paspalum conjugatum* indicated bhabor forest having moderate moisture in the forest floor. The riparian bed was naturally covered by *Saccharum spontaneum*, *Leea asiatica*, *Dryopteris palaecea*, *Crotolaria sp.*, along with tree sapling like *Bombax ceiba*, *Lagerstroemia parviflora*, *Dillenia pentagyna*, *Callicarpa arborea* and *Dalbergia sissoo*.

Several perennial water bodies generally adjacent to streams were characterized by complex hydro-seral stages even in small areas. These habitats were comprised of free floating hydrophytes, suspended submerged hydrophytes, anchored submerged hydrophytes, anchored hydrophytes with floating leaves, anchored hydrophytes with floating shoots, emergent amphibian hydrophytes and wetland species. The common aquatic plants in the former rhino habitat are *Vallisneria spiralis*, *Ottelia dismoides*, *Eichornia crassipes*, *Trapa nutans*, *Pistia stratiodes*, *Ceratophyllum demersum*, *Limnophylla sessiliflora*, *Vallisneria spiralis*, *Nymphoides cristatum*, *Nelumbo nucifera*. With increase of terrace height, several emergent amphibian hydrophytes like *Polygonum posumbu*, *Typha elephantine*, *Monocharia hastata*, *Hygroryza aristata*, *Leersia hexandra*, *Ipomoea aquatica* spread in the area. Besides several wetland sedges and short grass like *Cyperus brevifolius*, *C. digitatus*, *C. killingia*, *C. iria*, *Scirpus juncooides*, *Scripus grossus*, *Panicum paludosum*, *Paspalum conjugatum*, *Carax spiculata*, young *Phragmites karka*, *Arundo donox*, and non grass species *Lasia spinosa*, *Polygonum hydropiper*, *P. barbatum*, *Alpinia allughas* are distributed in the system. The wet tall grass *Phragmites karka* and *Arundo donox* along with non grass hydrophytes are highly competitive in the aquatic ecosystem present in the grassland areas. They



even invaded on the dead remains of the different hydro-seral stages. *Arundo donox* even found to grow with submerged and free floating hydrophytes. The distribution of aquatic species is based on the depth of the water as well as microhabitat condition. Some small water bodies even streams become dry in the winter season. The hydro-seral stages of the aquatic body could be related to the formation of wet grass community and swampy forest as a result of very long term temporal change. While presence of swampy forest was indicated by presence of wetland species like *Alpinia* and cane species *Calamus* as undergrowth vegetation, dominant tall wet grassland formation was confirmed by presence key grass species covering adjacent to aquatic community as well within it. We identified several low lying areas and water bodies in Bhuyanpara range that become shallow due to heavy siltation in fluvial period.

### **Food Plants**

Based on the field observation in Orang national park (Buddhin, 2007) in the north bank of Brahmaputra river having a rhino population of 68 numbers in 2006 and earlier information, several plant species were identified as potential food plants of Indian rhinoceros. It may be mentioned that Orang NP is very much similar with Pabitora WLS and Kaziranga NP (both are donor sources for rhino in the translocation) in terms of habitat condition i.e located in floodplain of Brahmaputra river. Even there are reports of migration of rhinos from Pabitora to Orang crossing the Brahmaputra river and its sandbars. The preferred food plants are namely *Arundo donox*, *Phragmites karka*, *Sacchrum ravennae*, *Cynadon dactylon*, *Imperata cylindrica*, *Hymenachne assamica*, *Hemarthia compressa*, *Leersia hexandra*, *Saccharum narenga*, *Saccharum spontaneum*, *Alpinia allughas*, *Vetiveria zizanooides*, *Andropogon sp*, *Sclerestachya fusca*, *Cyperus rotendus*, *Pallinia cilata*, *Ipomea reptens*, *Enhydra fluclueuce*, *Solanum carotenens*. Besides they selected young shoots of various trees like *Dalbergia sisso*, *Ziziphus jujuba*, fruit of *Trewia nodiflora*, *Gmelina arborea* etc. Under stress condition creeper weed like *Mikania micrantha* was consumed by translocated rhino that strayed from Manas several times. During flood season even *Eichornia crassipes* another problematic weed is taken by rhinos that suffered them loose motion (Hazarika, pers comm.). The rhinos also strayed to raid rice crops in fringe villages as observed in all protected areas of Assam.

### **Status of fenced grassland in Manas selected for rescued rhinos**

About 2 sq. km. of the Bansbari range of Manas and near to the boundary was specially surveyed during 2006. We found two major grassland associations namely *Saccharum narenga* (2.5 meter (m) tall) and *Imperata cylindrica* in uplands. It also included perennial stream - Kasimdoha known to be a former rhino breeding site in Manas. It is near to a forest camp (Gahari farm) having two plots initially (250m long & 150m wide, the connecting side of each plot has a wideness of 70

m, GPS point --26•40'43"N, 91•00'37"E & 26•40'31"N& 91•00'48"E) connected by a small corridor. It was prepared to keep three rescued young rhinos from the rescue and rehabilitation center near Kaziranga NP. The grassland in the plot as well as surrounding areas is mainly dominated by *Saccharum narenga* while *Themada villosa*, *Alpinia allughas* are also scattered in aquatic environment. A small seasonal drain (26•40'32"N 91•00'51"E) linked to the stream Gyati (approximate 5 m wide, 260m long inside the plot and 1 meter deep of water in December) is passing through the first plot. One rescued rhino was translocated on 2006 followed by another two numbers on 2007. From the security point of view (in 2006) the area is suitable for introduced rhino calf but during dry winter season very few wallowing site would be available as well as fresh food plants. The selective burning was suggested for growing of new palatable grass after observing the health condition of the animal during winter season. The area has been further extended covering some low lying areas followed by translocating fourth rescued rhino in the last year from rescue centre near Kaziranga.

### ***Management Constrains and prescription followed***

#### **Stray of rhinos**

There was history of stray incidents of rhinos in southern eastern fringes of Manas tiger reserve (Core zone). Interestingly the translocated wild rhino also strayed several times using these areas.

A strong monitoring group that included forest staffs and officials including administrative and police, conservation volunteers of all the local NGOs and field biologists provided security to the animal in such situations. Once even the animal was tranquilized and released in Manas again (detail in rhino crisis section).

#### **Exploitation of resource**

There is still some logging pressure in Panbari range, while river channels Manas has been used for smuggling timber and fuel wood. The smuggler even collected timber from Royal Manas national park, Bhutan and used the western buffer of Panabri range as exit route. The grass collection is confined in boundary areas of Manas. Poachers are still active in some pockets although the overall security of the park is better in comparison to 1989-2003 periods. The recent recovery of wildlife items including fresh parts in southern village of Bhuyanpara range and nearby town proved that wildlife traders are still active in some pockets.

There is a good network of different stakeholders and agencies working in the area that helped in minimizing the wildlife trade in the area. The incident of recent recovery of wildlife item is a good example of such good activities. The incident of grass and fuel wood collection has been

lowered with active participation of conservation volunteers of local NGOs. More poachers from Kahitema near Manas –Beki river system surrendered to the authority. The security forces and local administration also extended support to the forest department in antipoaching operations.

### **Status of Infrastructure**

The southern boundary needs to be completely restored immediately by construction of permanent bridges and restoration of degraded roads. There is also need to develop the remaining camps and beats with all facilities before the major rhino translocation to make the population to 20-30 in numbers. It may be mentioned that despite well designed security system sudden increase of poaching incidents in Kaziranga national park was a cause of concern in last 2-3 years.

Majority of the camps have been restored while the construction work of remaining camps in some points delayed due to adverse situation and technical difficulty. The bridges have been restored to facilitate two wheelers. There is a need of strong permanent bridge so that vehicle can be easily passed regularly particularly during crisis period.

### **Flood and threat of dam in Bhutan**

While low to moderate nature of flood favour in improvement of rhino habitats by maintaining successional grassland, creating new wallowing sites and recharging aquatic bodies, heavy flood created a great threat to the species in Manas. The heavy siltation by devastating flood blocked one major channel of Manas river system in 2004. The other channel bearing heavy water washed away several fringe villages of the reserve due to breaching of an embankment. This was due to excess release of water from Kurichu dam located in a tributary of Manas river in Bhutan. The same incident was repeated on 31<sup>st</sup> July, 2007 resulting breaching of the same Narayanguri embankment. It was reported that excess water released at a rate of 10500 cubic units per second from the Kurishu dam. The breaching site was very near to the central range office Bansbari. The main road between Borpeta road field director office and Bansbari range office was cut off due to this severe flood. Badly effected fringe villages of Manas tiger reserve were namely Narayanguri, Soonbari, Alangabari, Bispani, Kalpani, Churaguri, Khagrabari. The excess water through a channel called Kalpani moved to southeast direction and met another stream Palla that approaches to south west direction. This also threatened to the fringe villages in eastern side of the park and road approaching to Bhuyanpara range as well as alternative road to the Bansbari range. This flood also posed a threat to some areas inside the park. The riparian camps were washed away. The gradual increasing flood intensity in recent years also threatened the beautiful Mothanguri bungalow in Indo-Bhutan border. The crop fields in the fringes became unsuitable due to heavy siltation. Naturally the

human dependence on resources of Manas will be increased if a practical strategy is not taken to rehabilitate the affected villagers.

The local administration extended some support of flood relief and organized medical camps, later repaired and restored the Narayanguri embankment and road communication.

### **Man Animal Conflict**

The man animal conflict in the form of crop raids, household and property damage and injury and death by Asian elephant in the southern fringe is a continued threat. There is no buffer cover on the southern side of the Manas tiger reserve.

Some study on the conflict problem was done by some organizations. Department staffs, volunteers and villagers have a tough time during the conflict period.

### **Man power**

There was shortage of 150 forest staffs besides lack of well trained young officials in Manas during starting of Indian Rhino Vision-2020. Though presently volunteers of local NGOs have been extending support to the authority in patrolling the reserve, the shortage of well trained permanent forest guards must be fulfilled before the major translocation programme.

Gradually the forest department with support of other stakeholders provided fixed remuneration to conservation volunteers of local NGOs. Initially armed staffs from other departments have been engaged to fill up the gaps.

### **Burning Perspective**

Annual grassland burning pattern has been playing a major role in the temporal dynamics of the rhino habitat. The investigation indicated that intensity of the burning percentage of grassland was depended on the soil moisture of the area. The soil moisture in the upland areas reached significantly low level in dry season causing higher to severe burning (65-100%) in different patches of *Saccharum narenga* and *Imperata cylindrica* dominated assemblages whereas grassland assemblages of the low lying and swampy habitat showed low percentage of burning (10-40%) or remained unburned. The grass associations of riparian areas showed moderate burning (45-55%) due to diverse water holding capacity of the sand bars. The presence of control burning is limited. Better patrolling activities restricted illegal burning in some places. The presence of low moisture in Panbari range and low awareness of villagers might resulted severe burning just like other years observed by us since 2000. There has been improvement to keep the burning percentage low in central zone i.e. Bansbari range but areas adjacent to southern boundary could not be saved of anthropogenic burning while the low lying Bhuyanpara range naturally observed very low percentage burning due to high moisture content of the

biomass. We also look into the matter of recent forest fire caused in Manas landscape. While it is anthropogenic in nature, the draught observed in last winter caused heavy fire in eastern buffer areas of Manas.

The forest guards and volunteers were instructed by officials to check the anthropogenic burning in the grassland. We also suggested control mosaic burning pattern as well as early mid and late burning depending on the perspective of grassland habitat. During awareness and capacity building programme we always cover this issue.

### **Grassland Invasion**

High intensity of invasion by non grass tree *Bombax ceiba* was observed in *Imperata cylindrica*, *Saccharum narenga*, *Imperata cylindrica-Saccharum narenga*, *Saccharum spontaneum* assemblages in response to various disturbance situations like burn, burn-cut and burn-cut-external grazing while in disturbance free condition there was slow growth of the already existing saplings of the invasive species. Maximum increase of other non grass species like undershrubs *Leea asiatica* and *Chromolaena odorata* were noticed in the gap areas created by different disturbed conditions in the grassland of the Manas tiger reserve. The *Leea asiatica* is generally known to spread through underground propagules and locally cover the gap areas formed each year by continued disturbances, while *Bombax* has advantage of seeds attached to cotton ball that spreads through high speed wind. The preferred rhino areas i. e. Bhuyanpara range mainly dominated by *Phragmites karka*, *Themeda villosa*, *Alpinia allughas* type species was also gradually invaded by *Chromolaena odorata*, *Leea asiatica* and *Bombax ceiba* in adjacent boundary areas due to excess external biotic pressure. There are some buffalo bathan and almost most of villagers have domestic cattle that graze on the grassland of the tiger reserve. The *Alpinia allughas* growing in wet condition also has been decreased due to overexploitation and subsequent invasion by weed species *Chromolaena odorata*. The most threatened aquatic weed *Eichornia cracipes* was observed in southern boundary zone.

Awareness on impact of weed in Manas was started by us and message was gradually well understood by local, national and international stakeholders. During preparation of management plan, practical prescription to minimize weed problem was delivered to the authority of Manas biosphere reserve.

### **Medical facility**

Malaria is the main disease in the foot hills of Indo-Bhutan border. Each year, both forest staffs and villagers suffered badly in monsoon period due to malaria. In 2006, a few cases of death were also reported from the fringe villages. There is no good hospital in the region and people have

extra burden of expenditure for better treatment in outside. We also lost one of our colleagues Mr. Pankaj Sarma, project officer of WWF-India.

Recently death cases declined significantly due to better awareness, timely identification of malaria and necessary medication provided by medical camps, health centres and pharmacies.

### **Tourist Pressure**

Considering the improvement of law and order situation, excessive domestic tourist flow in the park was observed in 2005-2006. At least 450 plus vehicles entered on 1<sup>st</sup> January, 2006. Average 50-100 numbers of vehicle entered for successive 2 weeks. Tourists were not aware of the rule & regulation of the national park although forest guards tried their best to maintain the law inside the park. A better management of tourist was observed since 2007.

### ***Geo-spatial habitat suitability modeling of rhinoceros***

Apart from land cover map showing complexity of the rhino habitat, poaching threat map and habitat disturbance (integrating anthropogenic burning, resource exploitation, weed, and external grazing pressure) maps were generated. The final integration was done in two scenarios. The land cover map was subjected to only habitat disturbance map in scenario I while both habitat disturbance and poaching threat maps in Scenario II to design four classes of rhino habitat suitability. The suitability model categories the habitat in most suitable, suitable, less suitable and unsuitable zone. The analysis without poaching threat indicated the most suitable zone (42.35%) in grassland and adjacent swamp forest of eastern Bhuyanpara range and extending to central Bansbari range covering perennial water bodies including Manas river ecosystem and part of Panbari range. The buffer of the most suitable habitat comprises suitable habitat (38.72%) located in fragmented island grassland, unnoticed small ponds under the shade of deciduous forest in Indo-Bhutan border zone with several small streams, moderately moist grassland in western Panbari range and southern wet grass communities in low-lying zone. The GIS software identified a portion of forest in northeastern zone and grassland in western zone in same suitable category. Though grassland is more preferred by rhinos, the software gave more weight on the well protection measures by tribal community and authority in north eastern forest habitat with isolated aquatic bodies and island grass patches to place with the good grassland in western Panbari range but with moderate protection measure. The dryness of bhabor forest patches in north and different grassland areas in south particularly in south western side subjected to biotic pressure like resource collection, unscheduled burning, external grazing pressure by domestic cattle and increasing invasive species like *Chromolaena*, *Leea* and *Bombax* converted the suitable area to less suitable (13.35%)

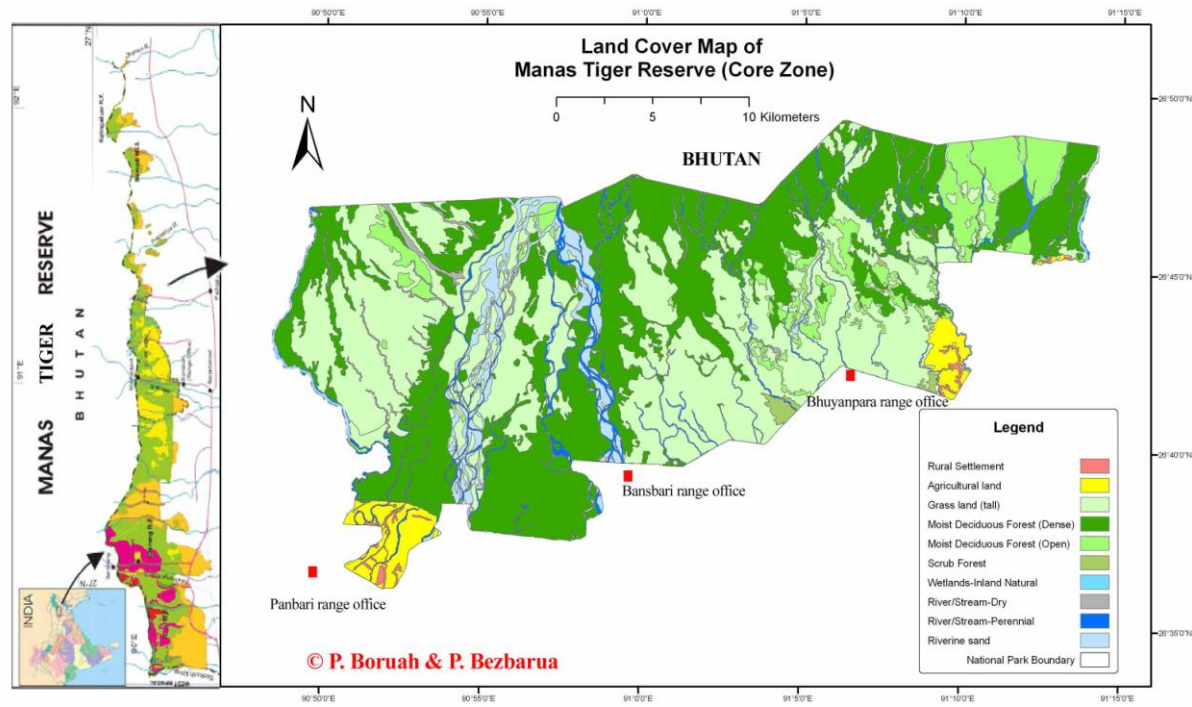


Fig 1. Land cover map of Manas Tiger Reserve (Core Zone)

One horned rhinoceros conservation in Manas Tiger Reserve

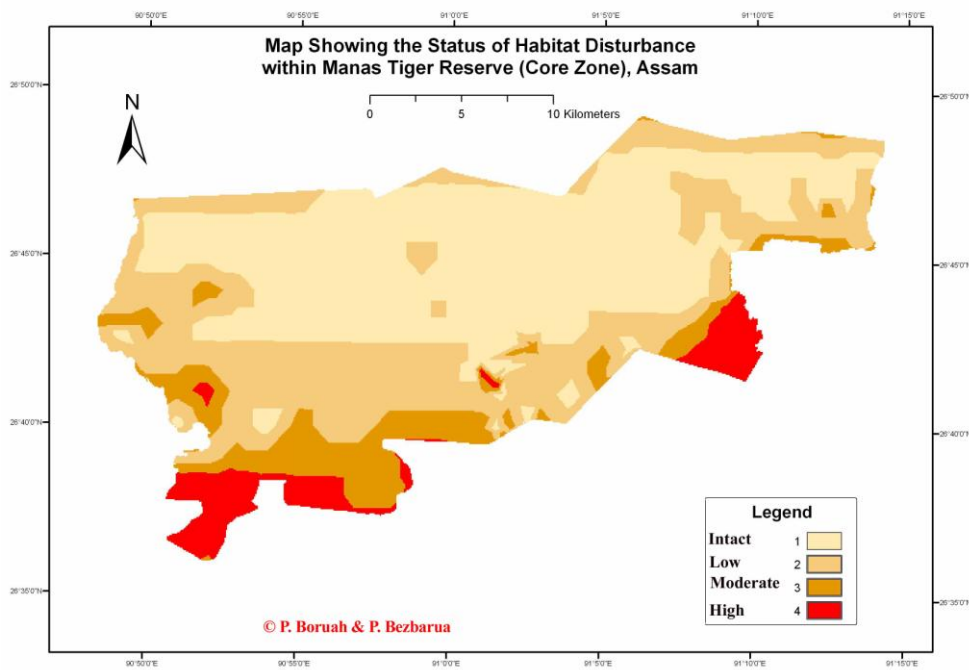


Fig 2. Habitat disturbance status in Manas Tiger Reserve

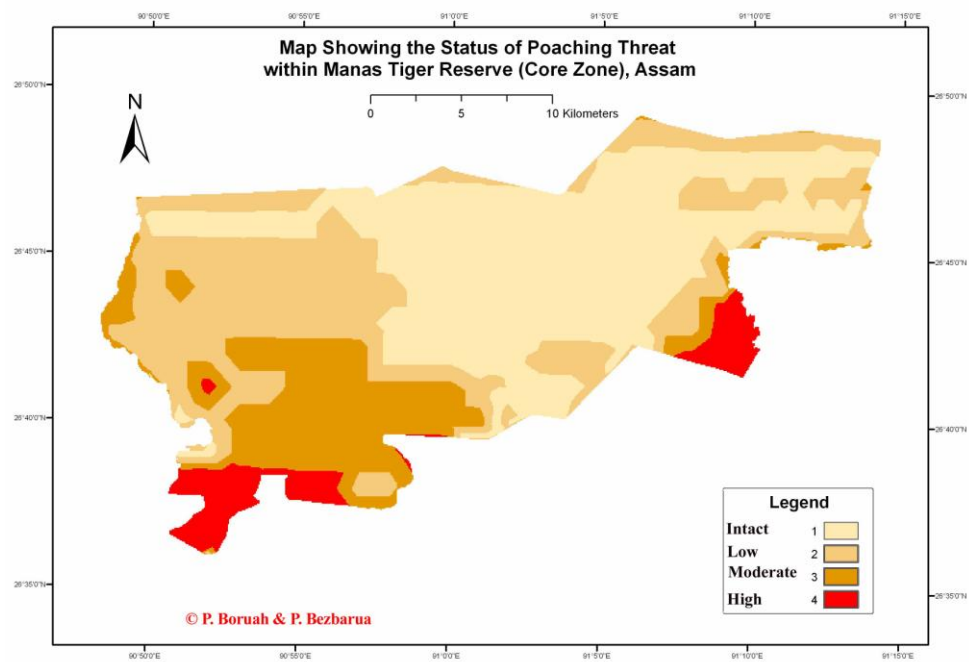


Fig 3. Poaching threat Status in Manas Tiger Reserve

One horned rhinoceros conservation in Manas Tiger Reserve



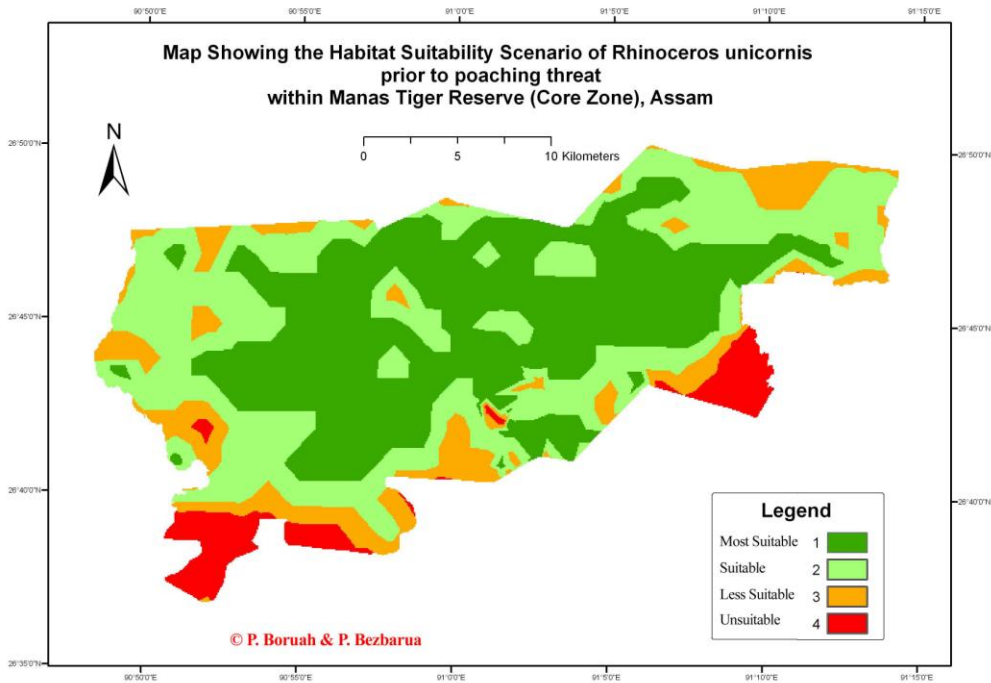


Fig. 4. Habitat suitability for *Rhinoceros unicornis* in Manas Tiger Reserve (Scenario I only habitat disturbance were considered)

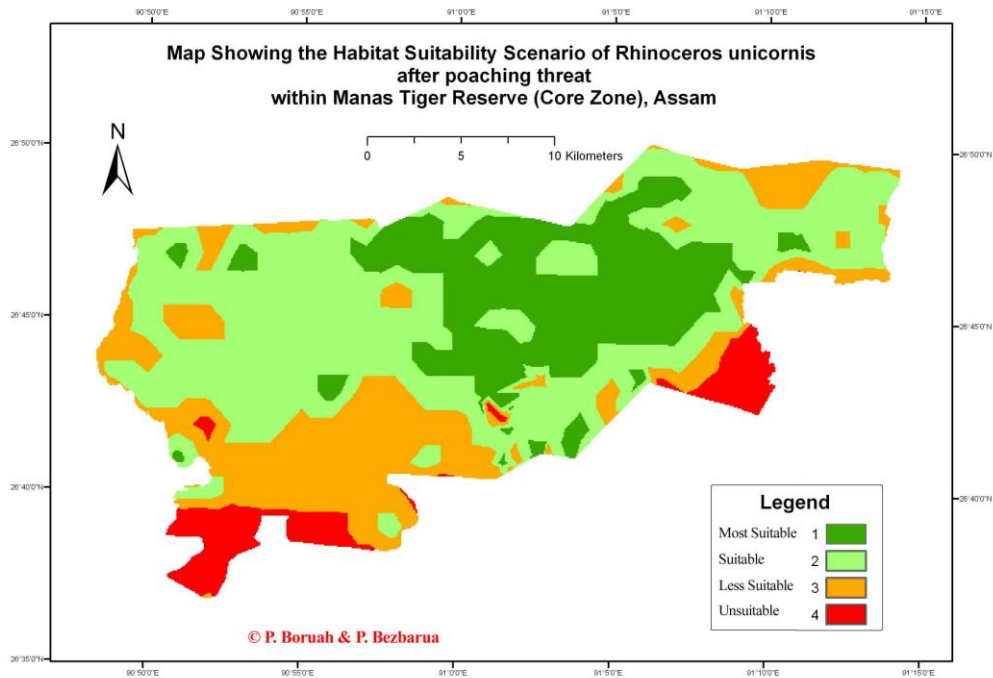


Fig. 5. Habitat suitability for *Rhinoceros unicornis* in Manas Tiger Reserve (Scenario II Both, Poaching threat and habitat disturbance were considered)

category. The encroached area in Panbari range and Bhuyapara range including degraded habitat are categorized as unsuitable (5.57%) zone. When we incorporated the poaching threat also linked with low awareness level and current socio-economic-political situation, the habitat suitability scenario significantly changed. The most suitable area decreased to 23.48% and there was slight increase of suitable area (46.33%) and unsuitable (6.02%) areas and moderate increase of less suitable area(24.16%). The most suitable and suitable areas in different pockets in Manas river ecosystem and western zone are identified as less suitable even unsuitable due to poaching threat.

We design the suitability considering both annual dry winter and flood season. There will be short time scarcity of food in Panbari range in dry season (February - March 10) followed by repeated burning of dry grassland. Secondly considering growth pattern of grassland (20 percent of sampling sites) influenced by excess water and draught condition, the current habitat suitability will show some change. We predicted that the most suitable, suitable and less suitable areas would show fluctuation to other category and vice versa about  $\pm 5-10\%$  depending upon the severe draught or heavy flood caused by low or excess rainfall including melting rate of glaciers in Bhutan Himalayas due to global warming and climate change.

While the 4 rescued young female rhinos translocated to fenced grassland confined within the space the two wild rhinos released in open space (26°41'46" N and 91°00'37" E) spent most of the time in most suitable and suitable habitat designed. Of course one male rhino spent in the fenced grassland for a long period while the second one strayed several times (detail in rhino stray section). One rhino calf died last year due to unknown reason and now there are 5 rhinos in Manas.

## Rehabilitation of Ex-poachers cum conservation Volunteers

### **Promotion of school education for the children of conservation Volunteers**

School bags with necessary education accessories were initially distributed to the children of 18 ex poachers residing in the fringe areas of Bhuyanpara range of Manas tiger reserve. It was distributed during the Sahitya Sabha (an annual large gathering or meeting to discuss various aspect of language and literature) of the Bodo community. The children are from eight villages and from six schools having age ranging from 3-10 years. The aim and objectives of Indian Rhino Vision-2020 was focused during the distribution of the school bags. This innovation method to promote education for the children of ex-poachers turned conservation volunteers has a good impact in the

local society to give more importance in education to the young generation. It helped to get additional support from other organization to replicate the model and we distributed school bags to the children of another 60 families identified as forest dependents and ex-poachers cum conservation workers from 23 fringe villages. All the 80 students are continuing their education. It was a satisfaction to us when a proud father and a hardcore ex rhino poachers cum hardcore conservation volunteer informed the visiting PTES official that his girl child had stood first in the annual examination. Now local NGO informed us that a few big organizations have come forward to provide scholarship to the school students of the forest dependents. A small beginning to save the children from being a future poacher or anti-social element, once unknown and neglected issue in the wildlife conservation movement, gradually get momentum and surely have long term impact in rhino conservation.

### **Alternative Livelihood Resource Generation Programme**

Based on the potential of the area we organized series of training programme on alternative livelihood generation to benefit the families of conservation volunteers. In the first phase training on plantation crop management was provided to 19 numbers of female and 3 numbers of male participants in Kokilabari area. Each trainee belonged to a member of either a family of ex poacher or forest dependent. This design was followed as per the discussion with members of local NGO Maozigendri. In kind support like rhizomes of Zinger (*Zingiber officinalis*), seeds of Pigeon pea (*Cajanas cajan*) was provided to two self help groups (female) having members 24 numbers and 10 numbers respectively. The most encouraging thing was that the participants had come forward for joint effort and working for the resource generation. Each member deposited a small amount to raise a common fund which was used for preparation of soil, bio-fencing and other related cost. One group even got allotment (one year lease in Kokilabari farm) of land for one year for rice cultivation. These activities although very simple but a new beginning by forest dependents/families of ex-poachers cum conservation volunteers significantly encouraged the other forest dependents. Observing the changing behavior, we planned to involve more forest dependents in the programme in phase by phase. In the second phase we supported in raising piggeries to three self help groups. All the groups found this option more easy and continue the works. The profit from the piggeries has been used by one group to cultivate rice as well as expenditure for the education of their children. In the third phase we also got additional support from another organization to continue the community conservation work. Last year a training programme on agricultural and veterinary resources and their disease control was organized. About 1000 numbers of Citrus saplings were

distributed to the 15 self help groups (having 10 members in each group) of the area. The resource person also explained the potentiality of multiple horticultural items in the same land for citrus, vermi-compost to get organic manure and raising duck amongst the beneficiaries. Apart from supplying natural vitamin C to the children and other family members, the citrus fruit has good demand in the market to increase the income level of the SHGs. Now we found more people coming for citrus plantation in the area. The average success rate of all beneficiary SHGS found to be increased from 35 percent (in first phase) to 50-60 percent, while one group did extremely well in all three items beside increased the income significantly and involve in rice cultivation by taking annual lease of land. Thus the model of alternative livelihood gradually empowers the women around Manas and surely will play a pivotal role in better involvement of society in rhino conservation.

The PTES trip in January helped our local partner Maozigendri in a crucial period of fund scarcity to supply ration for 80 conservation volunteers patrolling the eastern range of Manas biosphere reserve. This trip raised an amount about Indian Rupees 100,000 equal to 1370 pound plus global campaign by travel writers to promote ecotourism of the NGO and to continue their good work. A small amount of Indian Rupees 3283 was saved by us which was used as travel expenditure in extending the community conservation programme in eastern buffer areas. The area is a former rhino habitat and the present translocated rhino strayed there for several days. We jointly organized a seven days training programme on bee keeping and allied subjects like sericulture with collaboration with another local NGO, Government rural development department and Botany department, Gauhati University. Amongst the total 30 participants from 16 fringe villages of buffer zones, 20 persons selected bee keeping as preferred item. After the training, bee boxes and one live bee hive captured were distributed amongst the 10 SHGs formed by beneficiaries. The beneficiaries are from forest dependents and ex-poachers of the area. We also linked them with agencies for marketing the honey.

### Conservation education and capacity building in fringe villages of Rhino Habitat

We traveled and extensively visited the fringe areas of the Manas tiger reserve in January 2006 to evaluate the present perspective of conservation awareness level on Indian Rhinoceros and threat. We met local stakeholders that included village heads, villagers, local conservation groups, ex poachers turned conservation volunteers, teachers, students and forest officials including guards and officials of local administration. It helped in finding out gap areas that need immediate attention



Rhino conservation education material in local Language

regarding rhino conservation awareness. It had been noticed that although there was some improvement of security scenario; disturbance in terms of external grazing pressure from local cattle farms near the southern boundary of the park, collection of thatch grass logging and fuel wood exploitation mainly in the riparian and western range was continued to some extent. There were reports of some poachers in some areas though concrete information was not shared by local people at that time. The survey also indicated that most of the local people including teachers and local tribal leaders even some ground forest staffs and conservation NGOs and volunteers were also unaware about actual aim Indian Rhino Vision 2020. A few persons knew that rhino might be brought to Manas from Kaziranga.

Therefore we started our conservation campaign through discussion with the local stakeholders in their area. We learned the local problem faced by the stakeholders tried to find solution to minimize with an aim to link with ecological service provided by Manas landscape and its rhinos. We also explained how their problem is originated due to ecological boomerang in the area. We prepared a rhino conservation material in local language that focusing status of rhino and detail of Indian Rhino Vision 2020 and distributed it. Next with support of local NGOs, we campaigned for rhino conservation in small as well as big meetings. Focus on the needs of Manas and its rhinos as well as other wildlife were discussed during the awareness meetings where large numbers of local villagers, teachers, students, and community leaders actively participated. These conservation meetings found to be unique in the sense that we gave more importance on community conservation activities to motivate poor forest dependents to take alternative livelihood methods instead of forest resources. In village level meetings we mainly covered 27 villages of eastern and central range including buffer zones considering the immediate need to improve the awareness level as these were prime rhino habitat. Of course the participants from 49 villages attended in our different programmes. The opening and closing Manas centenary celebration and Bodo Savitya Sabha ( Bodo Language and literature Meeting) gave us the scope to reach local community of

most of the fringe of the tiger reserve even the buffer zone. Besides in later part, we discussed with two local NGOs working in western range and distributed leaflets as part of capacity building in their area. The limited fund was another cause we could not invest more time in western range. We also provided large number of leaflets to the six front line conservation NGOs working in core zone. We also monitored how these activities improve the rhino conservation awareness level amongst students and villagers. We observed that local conservation leaders and student replicated the rhino awareness campaign in villages besides discussing alternative livelihood generation works, ecological service by Manas and problem of weed.

### ***Additional work accomplished during the project period***

#### **Stray of Translocated Rhino: Chronology of the Crisis and our observation**

On 1<sup>st</sup> September, 2008 morning, we came to know from one member of a local NGO- Manas Maozigendri Ecotourism Society (MMES) that one translocated male rhino again had crossed the southern boundary through Betbari area of the Manas tiger reserve on the night of 31<sup>st</sup> August. The forest guard and conservation volunteers of MMES as well as other local conservation groups tried to push back the animal to the reserve. But the animal proceeded towards southern direction through paddy fields and located in Silbari area near Anchali which was aurally around 5 km south east from Betbari. The incident was immediately reported to the top forest officials of Assam Forest department as well as Manas tiger reserve. The rhino rested the night in the ponds covered by community bamboo forest. Domestic elephants were on move towards the area from the central range office Bansbari. There was large gathering of villagers that disturbed the animal. It further moved to southern direction and located in muddy crop field near Baghmara, aurally 10km south to nearest park boundary on 2<sup>nd</sup> September. The forest official and conservation volunteers has been trying to push back it towards the reserve including ensure protection of the animal while local administration and security forces of the area also extended help for overall control of the situation raised from gathering villagers. Possibility of tranquilizing the animal was discussed although the unfavorable ground condition i.e continuous rainy periods causing inundated the low lying areas, muddy grounds and bad roads for transportation of the animal were focused. Meanwhile the animal roamed around Soibari near Nityananda on 3<sup>rd</sup> September. We supported top forest official in Guwahati in sharing information from ground and GPS data was plotted in satellite imageries based map to get a better perspective of the movement pattern of the rhino. The information generated from the map has been immediately delivered to the concerned authority as well as ground that helped in better understanding of

the situation and taking appropriate measures. The map indicated that it was aerially 14 km south from Kokilabari beat, 16km south east from Bhuyanpara range (the eastern range of Manas national park) and 22 km south east from Bansbari range (central range). The animal crossed the Kaldia river and found roaming towards east direction. In the meantime, it was decided to tranquilize the animal despite bad weather. On 4<sup>th</sup> September, the animal moved further east and roamed around Pamapathar - Dalbil area near Musalpur- the headquarter of Baska district. One tranquilized expert visited the site with other veterinary experts. While the forest official and conservation NGOs continuously monitoring the situation another NGO- Manas Souci Konkhor Ecotourism Society (working the eastern buffer of Manas tiger reserve) joined the team. On 5<sup>th</sup> September, One biologist from department of Botany, Gauhati University,



Fig.6. Map showing rhino stray path in eastern fringes of the Manas Tiger Reserve

Guwahati rushed to the area via Hajo Nalbari road as the 31<sup>st</sup> National Highway near Rangia has been under water. Meanwhile the animal already crossed Morapagladia (one branch of Pagladia river system) and moved in the paddy field of Kadamtola village.

We observed that the rhino was very in stress condition. It was lying in a rice field having approximately 0.675 sq km that was surrounded mainly by thin community bamboo forest including *Areca catechu* plantation. We found that the rhino consumed *Mikania micrantha* a creeping weed, young bamboo (*Bambusa tulda*) leaves and rice leaves. Large gathering of people numbering near about 700 hundreds were watching the animal. Meanwhile we found tired conservation volunteers and forest officials. But the team continuously monitoring and protecting the animal day and night. One project officer of WWF was also in the spot to monitor the radio collared animal. Elephants were moved to the

place to cover the animal. Local administration discussed with the community leaders to maintain the law and order and safety of the animal. While we found people were very much interested to observe the animal, some enthusiastic young boys teased the animal, came close even touched it. The result was injury of a couple of young boys since the animal entered in human habitation. On 6<sup>th</sup> September strategies made to tranquilize the animal. The animal was located in a place called Khagrabari in the evening. On 7<sup>th</sup> September it moved to 5 km north east from the previous day's position. On 8<sup>th</sup> September it was located 2 km north to Dhamdhama. Forest official and other experts discussed that it would be risky to tranquilize the highly exhausted animal. Decision was taken to continue the monitoring of the animal. On 8<sup>th</sup> September it moved further east by crossing Pagladia river. It moves further south east direction during the period of 9<sup>th</sup> -11<sup>th</sup> September. On 12<sup>th</sup> September it was located in north side near another river Barnadi that was also close to the Barnadi wildlife sanctuary. At last on 13<sup>th</sup> September the radio-collared rhino was tranquilized and back to the Manas tiger reserve.

It may be mentioned the same rhino strayed several times in past. On 6<sup>th</sup> July we saw how the conservation volunteers and forest guards spent the whole night to prevent the animal to cross the eastern, southern and northern boundary of the park. That time one source informed us that sometimes signal from the radio collar had not been received properly due to technical problem and increase the risk to locate the exact location of the animal in night time.

There is a need to find out the stray behaviors of the rhino. First we think, all should agree that animal will not follow a boundary or area decided by human. In this particular case, this stray behavior of the translocated rhino might be feeling insecure in the new environment. Though rhino is a solitary animal it shared common wallowing site. Further it need mating partner. This wild rhino was from Pabitora wildlife sanctuary, having highest density of rhinos. The other male rhino released at the same time did not show the stray behaviour. As it found its partner in the fencing plot since mid June where four rescued female rhinos (one or two attained sexual maturity) were already translocated by the department. The wild male rhino in the fencing plot also drove away the other rhino (strayed rhino) when it tried to enter the fencing plot. During early part of our study, we came to know about several incidents of stray of rhinos in the south eastern boundary of Manas during paddy season. As rice is the primary crop of the region rhinos graze rice during summer period but generally confined to short distance from the boundary.

Therefore it can be concluded that the wild rhino should be translocated in cluster having both male and female. The initial plan was two male and two female at first phase. Though it was restricted to two rhinos at first phase yet one male and one female would naturally have less chances of stray in Manas. Further we must not forget if a major force, both conservation volunteers and forest staffs engaged in such



incident then security of the park will be at risk when there would be more rhinos. The common mass should be aware about the wildlife while allowing them to observe from a safe distance, avoid teasing the animal and extend support to the department.

### **Confidential Information**

a) We got information from one local informer about roaming of two rhinos in the Indo-Bhutan border areas in the February, 2006. Information also revealed that one active poacher tried to get a suitable gun during that period. We already informed the matter to the field director and deputy field director of Manas TR. Meanwhile, on eastern buffer in a site near Disima river stream one boy claimed to have seen a rhino on 2006. The pug mark was photographed by the authority. These incidents indicated that small population of rhinos still might exist in Bhutan. Meanwhile another source indicated that one person got information about 10-20 rhinos in a safe riparian zone of Royal Manas national park, Bhutan. There is a need of joint effort of authorities of India and Bhutan for surveying the existing rhino population in Bhutan for future management of the species.

b) One source reported me that he counted poaching of 106 rhinos since starting of the political turmoil in the region. I also gathered information from old ex poachers and even some top forest officials believed that actual rhino population exceeded 100 numbers and might be near 120-130 in the landscape covering some buffer forests also.

### **c) Socio economic and political perspective**

The political situation was significantly improved that resulted restoration of Manas and its biodiversity attributes. Different local NGOs in fringes of the Manas landscape converted the poachers and forest dependents to forest protectors. Yet some groups/individuals are trying to mislead one section of poor villagers having low awareness plus different political ideology. It may be mentioned that Bodoland Territorial Council was created after one group laid arms and formed the council. While major faction of another group is maintaining ceasefire with the government. The problem arises with some incidents related to law and order to get powers particularly during elections. The local NGOs working in different zones have persons with different political ideology. It has been observed that opportunists are trying to increase difference between these conservation groups. The level of success of different groups is also different. We agree that healthy competition is necessary. But there should be better coordination between the all groups particularly to deal with antipoaching operations and wildlife crime issue and always take support of forest authority and local administration.

Our partner NGO faced tough situations in eastern and western fringe villages in different periods. On western side of Kokilabari local villagers (having poor awareness) near Satrapa camp destroyed one

forest camp on 13<sup>th</sup> April, 2007 with the encouragement of an owner of Buffalo bathan. The situation was later controlled by the forest authority and local administration. There is also tendency of new encroachment in the Bhuyanpara range in these areas. Similarly in eastern buffer area they faced threat from local villagers due to restriction of timber felling and in a few incidents there was creation of law and order situation. Local administration and forest department controlled the situation in time.

The type of problem has been gradually minimized with continuous awareness programme by different stakeholders and formation of village based local conservation groups. We talked repeatedly to increase community conservation activities in these areas for long term conservation.

### **Other Activities**

- a) We supported two NGOs in writing project proposals for their different conservation programmes.
- b) We attended the meeting of Asian Rhino Specialist Group which was held in Kaziranga National Park in March, 2007. In the task force meeting (habitat section) we pointed out an important issue (dropped in the rapid habitat assessment report) the silent threats of invasion of *Leea asiatica* and *Chromolaena odorata* in rhino habitat of Manas as well as their low cost management strategies.
- c) We campaign at global level to attract more eco-tourist to visit Manas and have wonderful experience of traditional culture of local people as well as finding its wildlife. This will help the local NGOs to generate fund and contribute in conservation of the tiger reserve.
- d) We assisted visiting UNESCO mission to evaluate the overall perspective of Manas world Heritage (in danger) site.
- e) We used a portion of project money under travel head in increasing the field days of the project and instead of vehicle, used eco-friendly bicycle to contribute in minimizing global warming and climate change.

## Conclusion

- The rhino habitat suitability model indicated that Manas possess 122 sq. km. area as most suitable habitat, followed by 240.80 sq. km. as suitable, 125.57 sq. km as less suitable and 31.29 sq. km. as unsuitable. The most suitable area can be increased to 220 sq km. by minimizing the poaching threat and law and order problem near zero level. Currently the suitable area without poaching threat is covering 201.25 sq km. followed by less suitable 69.38 sq km. and unsuitable as 28.951 sq km.
- The microhabitat condition indicated presence of rich biophysical heterogeneity in grassland association having 11 types and complex hydro-seral stages of aquatic plant community. The forest covers 47.53 percent as deciduous forest including very less (less than 1 percent) area as close canopy evergreen and semievergreen forest.
- The suitability model proved that habitat diversity and availability is satisfactory in most of the area.
- The management constrains like incompleteness of some infrastructure with all modern facility, poaching threat in some points, weed invasion, illegal burning, resource exploitation influenced the habitat suitability. Of course the current prescription - joint work of forest department and local community found to be encouraging in restoring major areas of the Manas. The dam in Bhutan is a growing threat to the tiger reserve.
- The community conservation work related to rehabilitation of ex-poachers and forest dependent families showed positive result with 50-60 percent success.
- The capacity building on rhino conservation education and replication in different areas found to be satisfactory and need further extension in buffer areas.
- Additional work during the project period like monitoring of stray rhino, flood, helping volunteers and NGOs in different problems, raising issue in policy making meetings and gathering important information related to rhinoceros also carried out which would help in overall management of the species in long term.

## Recommendation

1. The security scenario should be improved through community participation and strict vigilance by the forest authority to encourage converting less suitable rhino habitats in riparian, boundary areas to suitable and most suitable category.
2. Community conservation work should be continued in fringes of Manas tiger reserve. The encroached area should be gradually restored involving local community by encouraging alternative livelihood which will be providing more income to villagers.
3. Rehabilitate all conservation volunteers (ex-poachers) including education to their children.
4. Numbers of well trained young permanent forest staffs should be increased. Govt. should provide remuneration to all conservation volunteers at higher rate. There should be well equipped facilities (ration, travel, antipoaching kits, night vision facility, arms etc) for forest staffs and volunteers involved in patrolling activities.
5. Organize well designed training to all staffs for using communication facility.
6. Family benefits like good quarters good schools, and medical facilities should be developed and improved in fringe areas.
7. While encouraging ecotourism, rural village economy should be also supported to minimize the dependence on resources of Manas tiger reserve.
8. The buffer areas on east and west side of Manas should be developed as part of long term rhino conservation.
9. The bridges in boundary road should be permanent so that four wheelers can move immediately during crisis period. Inside road and bridges should be also maintained in all season. Of course for low lying areas departmental elephant will do the purpose. Therefore number of patrolling elephant needs to be increased.
10. Regular vaccination of domestic cattle should be organized in all fringe villages.
11. Initiative should be taken to minimize the man-animal conflict particularly the man-elephant conflict in the fringe village. If possible adjacent 500 meter wide fringe crop field should be converted to spiny plants like citrus species which may minimize the elephant raid. Alternative crops which are avoided by elephants should be practiced. In buffer areas enough food plants of elephant need to be grown.

12. There should be an alternative to cattle & buffalo farm. Advanced methodology of dairy farm can be introduced where people will get more production and cattle need not to be pushed to grassland of Manas
13. Rain water harvesting in dry bhabor areas and drinking water facility for all forest camps of Manas in Indo-Bhutan borders should be available.
14. A balance sex ratio of rhinos needs to be maintained in future translocation. Absence of mating partner and competition might be the cause of recent stray.
15. There is a need of better balance in overall political situation including long term peace in the area.
16. The silted areas in rhino habitats need to be restored to maintain wetland grass community.
17. Control burning practice is a must and better involvement of grassland ecologists will help in maintaining the grassland habitat.
18. Eradicate the invasive weed before it covers large areas. Apart from existing *Chromolaena odorata*, *Leea asiatica*, and tree species *Bombax ceiba* covering large areas; *Eichornia crassipes* -the most problematic weed in water bodies is a new threat to Manas. Biomass sharing of weed, encouraging biological control through large wild herbivores like elephant and control burning prescribed by grassland ecologist should follow. The succession of *Bombax ceiba* in some prime rhino habitat should be prevented by eradicating the saplings at earliest.
19. Early warning systems of flood in Manas need to be developed through more cooperation with Bhutan. Stop developing of more dams in rivers that passing through Manas. Instead solar energy is a potential source of electricity.
20. Immediate opening of blocked channel of Manas river is necessary. Other wise the Panbari range- the western rhino habitats where once 30-40 rhinos roamed will be changed to unsuitable habitat. It will increase ecological density of rhinos in Manas and there would be a more threat to the whole population including frequent stray incidents.
21. The Makhibaha area a most suitable habitat of Bhuyanpara range can be a potential release site of translocated rhino by just improving the road communication.
22. Detail research in gap areas like ecology of translocated rhino, buffer habitat status etc. need to be carried out
23. Strong cooperation between all the conservation NGOs is needed. Forest department is doing good job by involving all in conservation works. Authority must design a strategy that benefits all the local NGOs involved in ecotourism. This umbrella needs to be strong enough for hundred percent successes to rhino conservation in Manas landscape.

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Plate 1 : Wallowing site



Plate 5 : Suitable rhino habitat



Plate 2 : Riparian habitat



Plate 6 : Grassland



Plate 3 : Anthropogenic burning



Plate 7 : Grazing pressure & *Leucaena asiatica* invasion



Plate 4 : *Chromolaena odorata* invasion



Plate 8: Encroachment Area In Panbari Range



Plate 9 : Fuelwood market near Manas TR



Plate 13 : Bombax ceiba invasion



Plate 10 : Fishing & Eichornia invasion in rhino habitat



Plate 14 : Flood cut off road communication



Plate 11 : Surrendered Arms by poachers



Plate 15 : Hardcore ex-poachers turned to conservation volunteers



Plate 12 : Restoration of forest camp



Plate 16: Restoration of boundary bridge





Plate 17 : School bag distribution to children of conservation volunteer



Plate 21 : Students with school bags



Plate 18 : Rhino mask attracted young students



Plate 22 : Rhino conservation awareness campaign



Plate 19 : Conservation education programme



Plate 23 : Distribution of Citrus saplings to self help groups



Plate 20 : Participants of capacity building programme on alternative livelihood generation



Plate 24: Piggery developed by SHG



Plate 25 : PTES tourists with conservation volunteers



Plate 29 : Forest guards & conservation volunteers patrolling in rhino habitat



Plate 26 : PTES official interacting with SHG



Plate 30 : PTES tourists with members of SHGs



Plate 27 : Wild adult rhino translocated to Manas



Plate 31 : Rescued translocated young rhino in fenced grassland in Manas



Plate 28 : Stray of translocated rhino

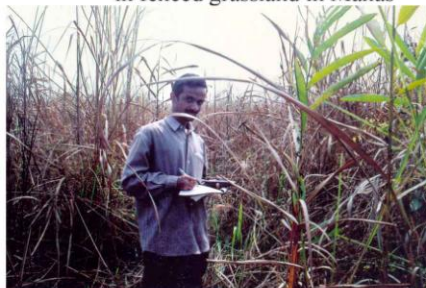


Plate 32: Principal investigator collecting data in rhino habitat

## Appendix I Local NGOs involved in the Programme

	<b>Name of Conservation Group</b>	<b>Name of the area covered</b>	<b>Zone</b>
1	Manas Souci Konkhor Ecotourism Society under NGO (Prateedhani)	Covering the eastern buffer namely Subonkhata, Uttarkuchi, Batabari R.F.	Eastern buffer
2	Manas Maozigendri Ecotourism Society	Major part of Bhuyanpara range, some parts of eastern buffer	Eastern buffer and core
3	Agrang Ecotourism Society	Bhuyanpara range southern eastern side	Core
4	Bhuyapara Ecotourism Society	Bhuyanpara and some parts of eastern Bansbari	Core
5	Manas Ever Welfare Society	Bansbari range covering the riparian side	Core
6	Panbari Manas National Park Protection & Ecotourism Society	Panbari range	Core & western buffer
7	Raiguli Ecotourism Society	West to Panbari i.e. Manas R.F near Kukloong	Western buffer
8	Green Manas	Stated working in Kahitema riparian zone of Manas-Beki river in Bansbari range	Core zone

## Appendix II Name of the villages involved in fringes of Manas Tiger Reserve

<b>Bhuyanpara range Core of Mans TR</b>	Dongpar, Agrang, Kumguri, Khusatari Bhuyanpara, New Betbari, Thaijwoguri, Majormakha, Rangidara, New Borgaon, New Randhanipara, Simlaguri, Chalchali North Khamardwisa, Randhanipara, South Khamardwisa, Hazirapara, Rangapani, Dwimguri (khamardwisa), Garumara, East Khamardwisa, 2 no. Kokilabari, Langdangpara, Daohara, Bhalaguri, Thebarmur, Hatijan, Daoharu.
<b>Bansbari Range Core of Mans TR</b>	Mayagpara, Palsiguri, Bishpani, Narayanguri, Katajhar, Gyati, Kahitema, Barengabari, Kahitema
<b>Panbari Range Core of Mans TR</b>	Provided education material to local NGO Panbari Manas National Park Protection & Ecotourism Society .
<b>Eastern buffer of Manas TR</b>	Uttarkuchi, Subankhata, Amlaiguri, Dimapur, Bandagui, Pachim ambari, Bhabanipur, Katabari, Bhujelsepa, Aliguri, Deghelipam, Bhutankhuti
<b>Western buffer</b>	Provided education material to local NGO Raiguli Ecotourism Society