Abstract: The Bornadi-Khalingduar Complex under the Manas Tiger Reserve, Assam is known to be an important area for wildlife movement to and from India and Bhutan. The contiguous landscape encompassing the two neighbouring countries provides a good habitat for diversity of wildlife and also as an important corridor area. We carried out an opportunistic camera-trapping exercise to document the faunal diversity in the area. A month-long exercise photo-captured a total of 19 species belonging to 12 families, including the Leopard, Wild Dog, Leopard Cat, Binturong, Elephant, Sambhar, Barking Deer and various birds. These findings of the study reveal the importance, threats and potential of the area and recommendations have been made to secure this corridor for continuous animal movement. Anthropogenic disturbance is a major deterrent to undisturbed animal movement in this area with resultant forest fragmentation and degradation. This indicates the need for effective conservation strategies in order to maintain the remnants of this corridor complex.

Keywords: Carnivores, connectivity, Manas Tiger Reserve, protection, threats.

Bornadi Wildlife Sanctuary, Khalingduar Reserve Forest and Neoli Proposed Reserve Forest in Assam together form a complex known as the Bornadi-Khalingduar (B-K) Complex and is the disjoint eastern part of the Manas Tiger Reserve. Administratively, this complex is under the Bodoland Territorial Council (BTC). The complex is an ideal bhabar tract of the eastern Himalayan foothills and provides an optimal habitat and opportunities for an east-west movement of elephants up to Manas (WWF 2010). It forms a buffer zone and serves as an important corridor for elephant movement from India to Bhutan. Previous records indicate the endangered Hispid Hare and Pigmy Hog were available here (WWF 2010). A great diversity of birds (218 species) and butterflies (135 species) has been recorded here (Annexures 4 and 5: WWF 2010), along with other animals.

A total of 102 elephants have been enumerated in the area in the recent census (Forest Department 2011). Although tigers have been known to...

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be present, no recent reliable records are available to prove their presence.

Bodo, Nepali and Adivasi are the major communities who have settled here with agriculture as the main means of subsistence. Apart from bigger and older tea estates in the area, smaller tea gardens have developed extensively in the last 4–5 years along the protected area boundary posing a threat to wildlife movement. Illegal extraction of forest products and occasional hunting of animals are threats to the forests and wildlife. Massive deforestation took place between the years 1991 and 2001; but this damaging activity is gradually decreasing due to the intervention of the Sashastra Seema Bal (SSB) personnel in the area, who were deployed to combat militant activities (WWF 2010). The resultant human-elephant conflict (HEC) following habitat shrinkage has assumed alarming proportions in the area (Hiten Baishya, pers. comm. 2014). Also, grasslands are getting converted into mixed dry deciduous forests as a part of natural succession where *Bombax ceiba* and *Dillenia pentagyna* invade the grassland habitat (Hiten Baishya, pers. comm. 2014). Large grasslands are an important habitat for mega herbivores like elephants, therefore proper habitat management needs to be implemented; the semi-evergreen forest has decreased largely in Neoli, due to encroachment and rampant illegal felling of trees, and the riverine grassland in the southern extension of Khalingduar and the scrubland have changed to settlement and cropland (WWF 2010).

In order to formulate effective protection and management strategies for a particular protected area it is essential to have sufficient knowledge of the animal species present there, their numbers and distribution status. Among the various field techniques, camera trapping is considered one of the best to document the diversity of animals without causing much disturbance, both to the environment and to the animals. Thus in this study we have used camera traps to document the diversity of animals found in our study site.

**Objective**

The objective of the present study was to generate baseline information of the wildlife and to assess the present threat with reference to Bornadi Wildlife Sanctuary (WS) and Khalingduar Reserve Forest (RF).

**STUDY AREA**

Bornadi WS (26.22km², 26°48’21”N & 91°44’25”E) is located in the Baksa District of Assam (Fig. 1). It was declared a wildlife sanctuary in 1980. It has a designation of an Important Bird Area (IBA) (Birdlife International 2013). The river Bornadi forms the western boundary and Nalanadi River forms the eastern boundary of the sanctuary. The sanctuary lies in a bhabar zone. So the area is mainly composed with sediments deposited by the river flowing through Bhutan (Sharma & Sharma 2008). The vegetation is tropical semi-evergreen, tropical moist and dry deciduous type. The altitude ranges from 150–200 m. Average annual rainfall is 400mm. Khalingduar RF, (70.33km², 26°52’14”N & 91°53’01”E) is located in the Udalguri District. The altitude ranges from 250–450 m. The average annual temperatures range from about 8°C in January to 30°C in July. The vegetation is moist deciduous, semi-evergreen and mixed deciduous type. Neoli (11.48km²) is a proposed reserve forest and lies between Bornadi WS and Khalingduar RF.

**METHODS**

We carried out an initial reconnaissance survey, which consisted of surveys of animal signs such as pugmarks, scats, rake marks, kills, hoof marks, pellets etc. and recording their GPS locations. Following this, we deployed camera-traps in different locations where indirect animal signs were common. We carried out this rapid and intensive camera-trapping exercise for about a month from October to November 2012. We used RECONYX (PC800 HyperFire) camera traps for the study and kept them operational for 24 hours a day. After a month-long exercise we collected photographs of a variety of wildlife (Image 1).

**RESULTS**

We began our camera-trapping exercise from October to November 2012 in Bornadi WS and Khalingduar RF. During this period we photo-captured a total of 19 species of animals from 12 mammal families and two avian families; the list of the recorded animals is given below: 1. Common Leopard *Panthera pardus*, 2. Wild Dog *Cuon alpinus*, 3. Leopard Cat *Prionailurus bengalensis*, 4. Binturong *Arctictis binturong*, 5. Yellow-throated Marten *Martes flavigula*, 6. Crab-eating Mongoose *Herpestes urva*, 7. Asiatic Elephant *Elephas maximus*, 8. Gaur *Bos gaurus*, 9. Sambar *Rusa unicolor*, 10. Barking Deer *Muntiacus muntjac*, 11. Wild Pig *Sus scrofa*, 12. Rhesus Macaque *Macaca mulata*, 13. Assamese Macaque *Macaca assamensis*, 14. Himalayan Crestless Porcupine *Hystrix brachyura*, 15. Indian Hare *Lepus nigricollis*, 16. Indian Peafowl *Pavo cristatus*, 17. Khalij Pheasant *Lophura leucomelanos*, 18. Red Jungle Fowl *Gallus gallus*, 19. Black Stork *Ciconia nigra*.
Faunal diversity of Bornadi-Khalingduar Complex

Chakraborty et al.

Carnivores

Leopard: The Leopard Panthera pardus is the major carnivore in the B-K complex in the absence of tigers. The apparently low abundance of natural prey species is compensated for by livestock owned by the local villagers. It has adapted to the loss of its natural habitat and takes shelter in agricultural fields and tea plantations and other areas in the human settlements. Surprisingly though, no reports on conflict with humans in the area exist yet.

Wild Dog: Wild Dogs or Dholes Cuon alpinus occur mostly in the forest areas near the border of Indo-Bhutan and do not venture out near human habitations. Interestingly the villagers are not aware that these animals exist in the area. Wild Dogs compete with Leopards for resources and contribute to keep the population of ungulates in the B-K complex balanced.

Herbivores

Asiatic Elephant: The Asiatic Elephant Elephas maximus prefers a diverse habitat combination of open grassland, scrubland and woodland. Thus the B-K complex forms a favourable habitat for their use and further movement to larger forest tracts in Bhutan. However, the gradual loss of forest due to human interference has forced the elephants towards crop fields searching for food (Hiten Baishya, pers. comm. 2014). This has resulted in escalating conflicts with humans living in the encroached areas, as well as in the fringe areas of the complex (Hiten Baishya, pers. comm. 2014).

Gaur: Gaur Bos gaurus are not found in many forests of Assam. Their presence in the B-K complex indicates the health of the forests to hold such large ungulate species which form one of the primary prey species of the Tiger and Leopard.

Birds

Galliformes: Galliformes are an order of diverse birds comprising Jungle Fowl Gallus gallus, Khaleej Pheasant Lophura leucomelanos, Indian Peafowl Pavo cristatus, etc., found in the complex. They play an important role in the ecosystem by dispersing seeds and seed predation, thus keeping the forests alive and productive.

DISCUSSION

The B-K complex continues into the dense forest complex of Khaling WS in Bhutan, which in turn is contiguous with the large and important forest network of the country. This network of forests harbour a
variety of wild flora and fauna and is also well protected, compared to the Indian part. The connectivity with Bhutan and the better protection of wildlife there gives the animals an advantage to cross over from India since that stretch of undisturbed habitat is conducive for their survival. This is because the Royal Government of Bhutan is committed to wildlife conservation and has set aside more than 51% of the country’s total geographic area as protected areas in the form of national parks and biological corridors (Borah et al. 2013). The presence of the wide variety of mammal species in the landscape could be attributed to the varied topography as well as the different vegetation types which favour different habitat requirements of various animal species (Borah et al. 2013). This ensures a continuous supply of prey for all the variety of carnivores present here. This habitat, thus, has the potential to hold a small transient Tiger population, if not residents, moving between the two countries during their annual migration, search for food, etc. However, due to the fragmented and
highly disturbed status of the complex, this might not be possible at present. The disturbance by humans is a serious problem and needs effective protection strategies for the area to curb deforestation, encroachments and other detrimental activities. This would require collaborative assistance from the authorities including from the Bodoland Territorial Council (BTC), under whom the area falls, as well the civil administration, local communities and other relevant stakeholders.

THREATS

We have recognised various threats in the corridor complex which are broadly discussed below (Image 2):

1. Undesirable land use change: Due to the massive deforestation from 1991–2001, a major chunk of the vegetation cover has been lost (WWF 2010). This has led to an extensive infestation of invasive weeds like Mikania macrantha, Lantana camara, Ageratum conyzoides, Eupatorium odoratum, Lea crispa, and Mimosa invisa, rendering loss of food plants for wild animals (WWF 2010). Also, due to livestock rearing, collection of bamboo, other NTFP and timber from the forest, there is direct competition for food among the native wild animals.

Due to continuous encroachment of the forests for settlement, agriculture, and demand for natural resources, the habitat for wildlife has undergone great losses. As a result HEC has amounted to escalated proportions. At Neoli, the expansion of human settlements along with agriculture in the last decade has dealt an extensive loss to the habitat.

SSB camps along the Indo-Bhutan boundary, particularly in certain critical corridor areas, especially near the Samrang River, are a cause of disturbance for the movement of elephants and other animals through the area (WWF 2010).

A new road (more than 300km long) has been proposed along the border of India and Bhutan which is expected to pass through the longitudinal stretch of Manas Tiger Reserve, starting from Jamduar (near Sankosh River, west of Chirang RF) to Bhairavkunda (east of Kalingduar RF) (source: http://tarungogoi.in/cmsmaster.php?displayid=SL-100008). The construction of the road will have a devastating impact on the forest and wildlife in this stretch, unless proper mitigation measures are adopted.

2. Management issues: The area around Bogamati in Bornadi WS has been cleared of the forest by encroachers to develop an amusement park, social clubs, households etc. The area is frequented by elephants, and the disturbance caused by humans recently is a major impediment for elephants, birds and other wildlife. Small scale hunting, firewood and timber collection also goes on unabated.

The complex lies in the bhabar zone, where the ability of the soil to retain water is comparatively less. The resultant scarcity of ground water in the complex is an age-old problem, leading to a decrease in soil productivity for cultivation of paddy or other crops, and people who have settled there are in constant struggle to harvest it. To overcome the constraints of surface water people have developed an indigenous practice of water harvesting, locally known as ‘Dong’. The dong practice in the area is a traditional system of collecting water from the streams and river in the hills through man-made conduits, using the principles of watershed. However, this system has not been propagated in a sustainable scale due to a lack of scientific up gradation against the rising need of the resource due to an increase in the population; therefore the scarcity of water still remains a problem (WWF 2010).

3. Socio-political instability: The socio-political instability in the area is one of the major constraints affecting the delivery of various developmental and conservation initiatives.

Recommendation and Conclusion

The people of the area, though aware of the importance of wildlife, have not been able to realise the need for long-term management of natural resources, due to their immediate livelihood needs and a lack of basic education. Also, their inability to develop a sustainable livelihood through agriculture is the major cause for their unsustainable dependency on forest resources. Thus, sustainable alternatives for livelihood management, along with a better education system, focussing on the importance of a healthy environment may be helpful for a brighter future. We also think that restoration of the degraded habitat is essential to secure this excellent corridor for movement of large mammals including tigers and elephants.

Based on the above mentioned threats we recommend the following steps which will help in better management and conservation of this important habitat complex:

1. Strict enforcement of wildlife laws should be the top priority.
2. Habitat improvement activity needs to be initiated including grassland management, plantation of native tree species and elimination of weed and exotic species.
3. Scientific intervention through contour banding,
gully plugging and increasing riparian vegetation cover need to be taken up to harness more significant result for dong practice.

4. HWC management measures need to continue in a more efficient way.

5. Fringe communities need to be involved in the conservation initiative through various benefit-sharing schemes, e.g., JFMC and EDCs.

6. A further detailed study of the flora and fauna needs to take place, using occupancy framework and extensive camera trapping, for developing a robust conservation action plan.

7. Regular awareness campaigns targeting various sections of the society are recommended.

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