

ASSESSMENT OF BIODIVERSITY VALUE OF GAUTAM BUDDHA WILDLIFE SANCTUARY

TECHNICAL REPORT



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EXECUTIVE SUMMARY

The rapid growth of Indian economy has created demand for additional capacity of rail freight transportation, and this is likely to grow further in the future. The Eastern Dedicated freight corridor from Dankuni in West Bengal to Ludhiana in Punjab with a route length of 1856 Km is passing through Bihar (239 Km) and Jharkhand (196) which crosses through the Gautam Buddha Wildlife Sanctuary situated on Bihar and Jharkhand border. The upcoming corridor development on the proposed alignment through the sanctuary area requires a prior Biodiversity and Impact assessment study. The Dedicated Freight Corridor Corporation of India Ltd. (DFCCIL) requested the Wildlife Institute of India (WII) to assess the Biodiversity Value of Gautam Buddha WLS.

A total of 25 rivers and streams are recorded in the sanctuary including both perennial and seasonal.
(Management plan, 2008).

The Wildlife Institute of India conducted a rapid biodiversity assessment of the sanctuary for 6 months from March, 2017 to September 2017. The assessment was carried out using 1km transect survey in every 2 sq. Km grids distributed throughout the sanctuary for the faunal and floral diversity of the area. The present status of the sanctuary shows a good floral and faunal diversity with more than 100 species of plants and 75 species of birds. The PA's are also rich in mammalian, herpetofauna and entomofauna.

The sanctuary has a significant role to play in the weather, microclimate and watershed management for the region. This protected area of forest harbours a number of streams and rivers both perennial and seasonal which is the source for surface flow and groundwater recharge as well. The sanctuary has an eminent role to play in ecosystem services like climate

change resilience and adaptation. It is a transitional area between the chottanagpur plateau and Gangetic plains and the only remaining natural forest area in this geography.

The area of the sanctuary from where the proposed alignment of Koderma detour is passing encompasses some of the pristine forest pockets existing in the sanctuary which is also a favourable habitat for some of the Rare, Endangered and Threatened (R.E.T) species like Sloth Bear and Egyptian Vulture. The sanctuary is already facing the biodiversity and habitat loss due to anthropogenic pressure and activities.

Habitat fragmentation and loss due to linear infrastructure development is an issue of great significance which needs to be considered with due diligence and priority. This sanctuary is already fragmented by a major linear infrastructure of NH-2 (G.T Road). The impact of the proposed alignment of the dedicated freight corridor on the diversity and habitat of the sanctuary needs to be assessed. The impact assessment study of the proposed alignment area will highlight the potential impacts of the rail corridor on the biodiversity and habitat of the sanctuary and will enable to foresee the feasibility of the project and suggest the most suitable mitigatory and compensatory measures to be taken.



INTRODUCTION

The Convention on Biological Diversity (CBD) defines biodiversity as “the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.”

Species richness and genetic diversity is an important aspect of biodiversity that influences the ecosystem processes and functions (Chapin et al. 1997). The biodiversity is significant for sustainability of the ecosystem which benefits the human society in multiple ways like food security, health, medicine, livelihood, regulating and controlling spread of diseases, disaster risk reduction, nutrient cycling, air purification, micro climate variability, cultural and spiritual values for the communities (UN CBD COP 10 Policy brief, 2010). The biodiversity is economically valuable to human society as it provides essential goods and services important for healthy living (Gamfeldt et al. 2008).

India, a megadiverse country with only 2.4% of the world's land area, harbours 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals has a huge challenge to integrate its development and growth needs with biodiversity conservation for a sustainable future (MoEF&CC, 2014). In view of this, India took up a significant step for inventorying its vast and diverse biological heritage. The gap between development needs and conservation is being minimized by mainstreaming approach which embeds the conservation principle in development (WII, 2016). This approach embraces the concept of Green Infrastructure which looks at conservation values and actions in concert with land development, growth management and built infrastructure planning (Benedict 2000). Green infrastructure helps to build robust healthy and enduring landscapes which enable species and their communities to move and adapt (Lucius et al. 2011).

The loss of biodiversity and habitat due to rapid development triggered an alarming call for an urgent redressal of the issue, the Conference of the Parties of the Convention on Biological Diversity (CBD) adopted a Strategic Plan in 2002 (Khera and Kumar, 2010). In 2002 at sixth meeting (The Hague), the COP endorsed draft guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or processes and in strategic environmental assessment (Decision VI/7- A) (Secretariat of CBD, 2006). India incorporated these guidelines through amendments in various Acts dealing with biodiversity and EIA Notification of 2006 and its amendments (WII, 2016; Khera and Kumar, 2010). Inclusion of biodiversity in EIA is a two-way process. It not only draws on information on biodiversity but also generates useful biodiversity data (Treweek, 2001). The biodiversity assessment provides the baseline data for the area and any failure in collection can greatly hamper the impact prediction. The inadequate biodiversity consideration in project development or Environment Clearances leads to unreliable and poor outcome for conservation as well as human well being (Slootweg et al, 2010; Rajvanshi et al, 2010).

2.1.SCOPE OF THE PROJECT

The DFCCIL have requested the WII to conduct a Biodiversity Assessment of GBWLS vide letter No.- KKK/EN/LA/KQRdetour/Gayaforest/1518 dated 13/01/2016. Following this request the WII undertook the project aimed to assess and study the biodiversity value of the Gautam Buddha Wildlife Sanctuary in Bihar and Jharkhand. The sanctuary is part of Chottanagpur Plateau landscape which is surrounded by industrial and mining areas of Koderma, Hazaribagh districts. This study has been undertaken with regard to the proposed alignment of Dedicated Freight Corridor i.e. Koderma detour of around 12 km passing through the core and buffer area of the sanctuary. The mandate of the study is limited to the assessment of floral and faunal diversity of the sanctuary. The components assessed for the study are: Vegetation, Mammals, Birds, Herpetofauna and Butterflies. These components will represent the actual biodiversity value of the sanctuary.



STUDY AREA

The Gautam Buddha Wildlife Sanctuary is spread over an area of 259.5 sq. Km and was notified by Govt. of Bihar by vide notification no. 1368 on 14th September, 1976. Prior to becoming a wildlife sanctuary, the area was a private hunting reserve. The forest of the sanctuary is located on the hill and undulating tracts lying north of the hilly terrain which is an extension of Chottanagpur plateau. The sanctuary is drained by river Mohane which is perennial and sink for all the streams and rivulets flowing in the sanctuary.

The sanctuary falls in the states of Bihar (138.4 km²) and Jharkhand (121.14 km²) managed by forest divisions of Gaya and Hazaribagh (Wildlife) respectively.

The sanctuary lies in 6B Deccan peninsula-Chotta-Nagpur biogeographic province of India (Rodgers et al, 2000). The sanctuary is situated in Gaya district, Bihar and Hazaribagh, Chatra district of Jharkhand which is fragmented into two halves by NH 2 (Grand Trunk Road) passing through almost the centre of the sanctuary (Singh et al, 1988).

Historically, the sanctuary was a game reserve of Tikari Estate before being notified as a sanctuary in 1976.

According to the classification of the Forest Types of India by Champion and Seth, the forests of the area fall under a broad category of Northern Tropical Dry Deciduous forest (Mishra et al, 2008), which has been sub-classified as follows:

- (a) Dry Peninsular sal (5B/C1c)
- (b) Northern dry mixed deciduous forest (5B/C2).
- (c) Dry Bamboo brake (5/E9)

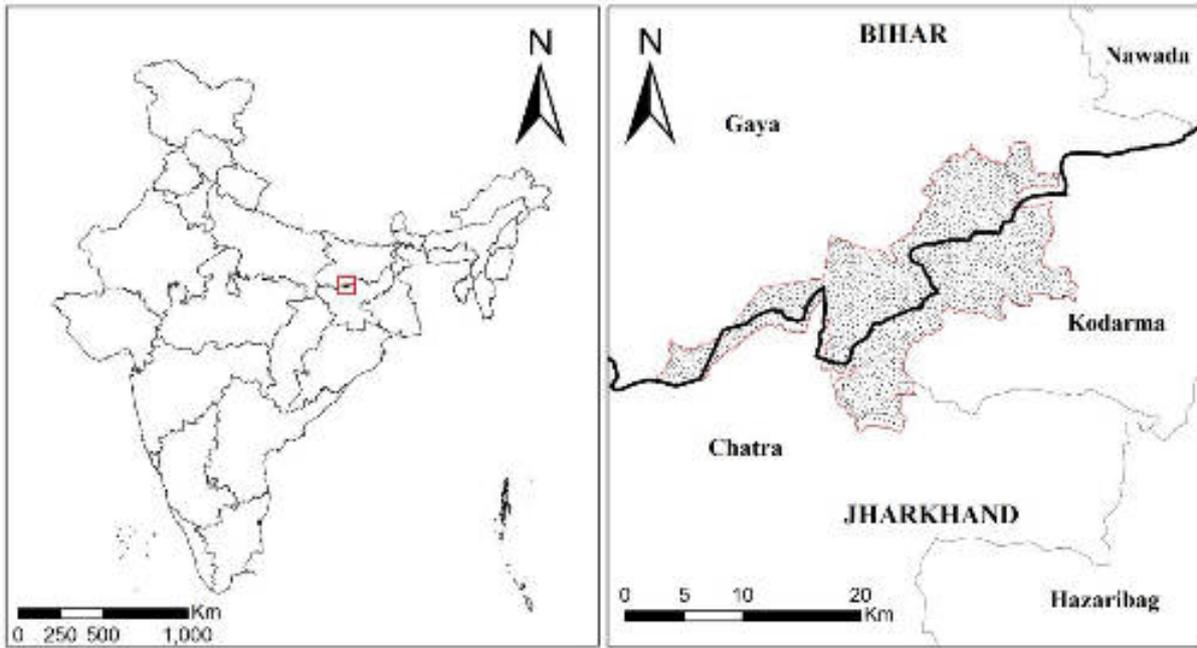


Figure 1: Study Area Map of Gautam Buddha Wildlife Sanctuary Bihar and Jharkhand.

The vegetation is of the tropical dry deciduous type that sustains life for a number of animal species. The Sanctuary also has a large population of human and livestock that has tremendous biotic impact on the natural wealth leading to loss of biodiversity and ecological degradation (Kumar 2016).

Geologically, two types of formations – Archaen type & gondawanas type exist in the area. Main rock types of Archaen formation are granite and gneiss, whereas sandstone, shale and quartzite constitute Gondwana formation. The archaens occupies almost whole of the area, while the lower gondawanas occur in the form of few detached outliners represented by shale, sandstone & boulder bed. The above formations are overlain by the recent alluvium and gravels brought down by the rivers flowing in the area (Mishra et al, 2008).

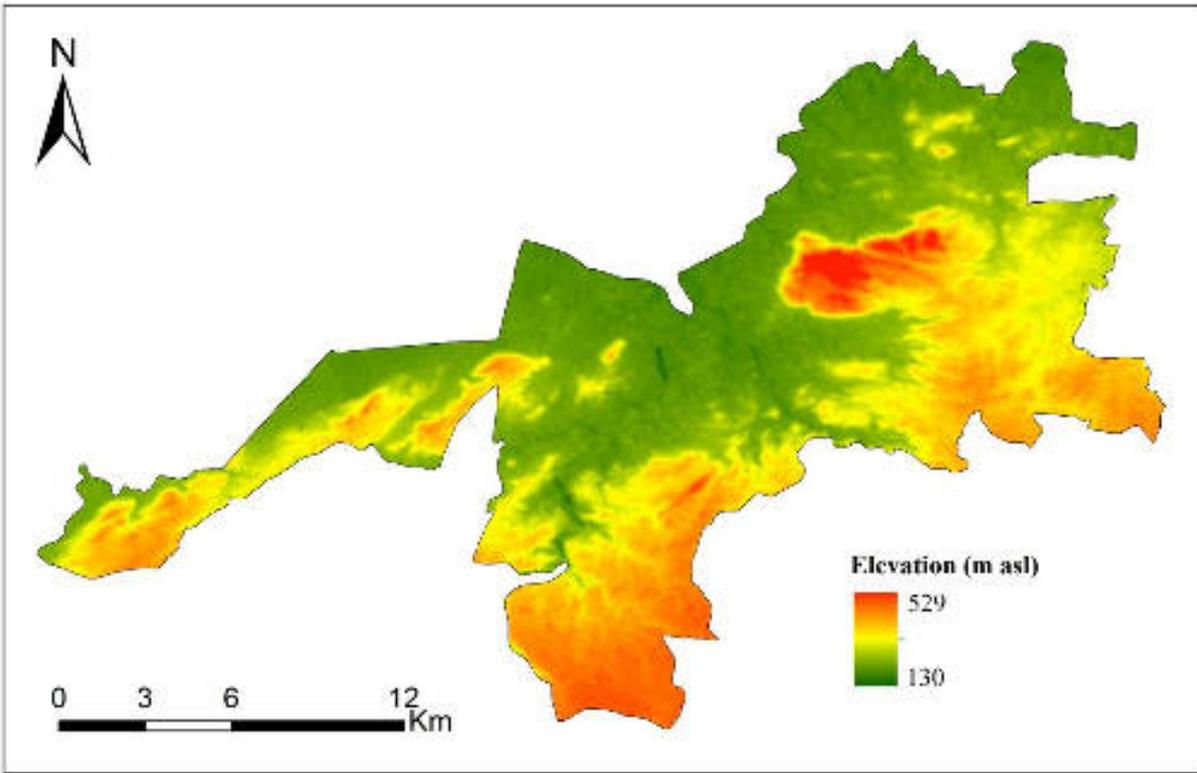


Figure 2: Map showing elevation range of GBWLS topography.

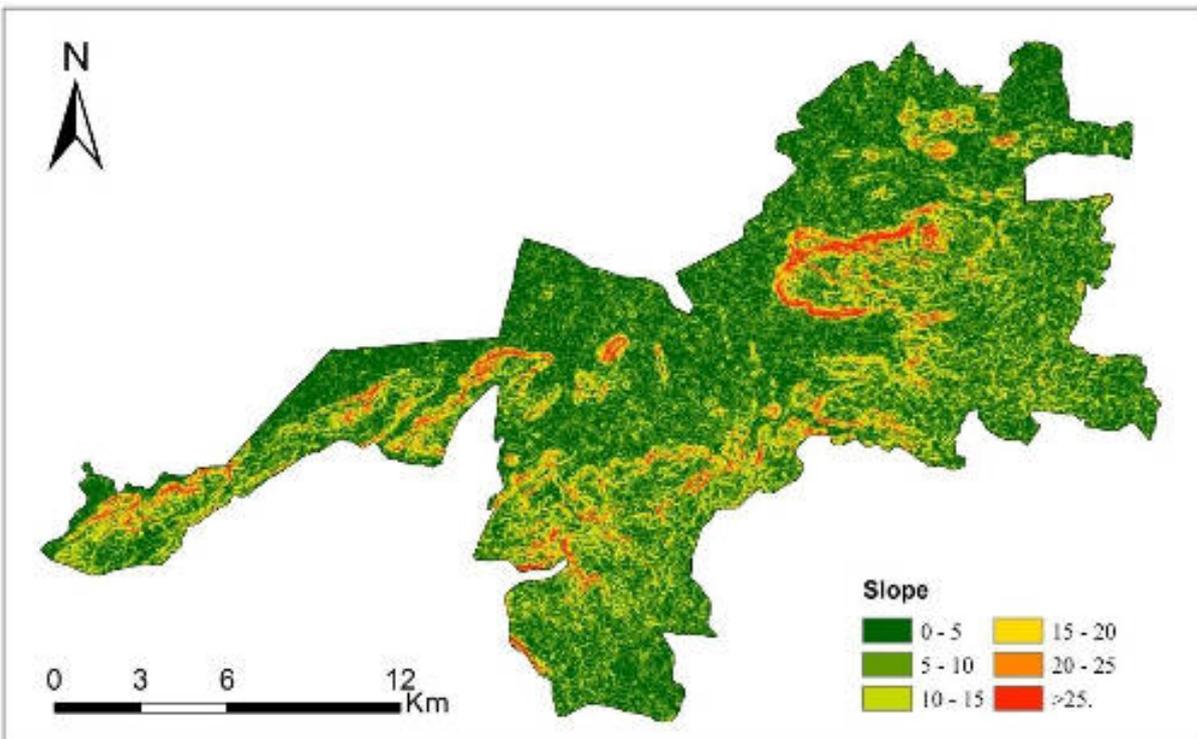


Figure 3: Map showing slope and terrain of GBWLS.

The Soil is very deep in valleys and plains and is loamy or sandy loam in texture, supporting dense semi-deciduous Sal forests interspersed with grasslands, making the sanctuary an ideal habitat for a variety of fauna. On the hills, soils are shallow, while the forest is of miscellaneous type (Ambasta, 2016).



METHODOLOGY

To assess the biodiversity of the sanctuary, the entire area was divided into 2 sq. Km grids and in each grid transect of 1 km length was covered to assess the occurrence of wildlife and the status of their habitat. The survey was conducted for a period of 45 days in the month of July and August, 2017. Each transect was walked once to collect the direct and indirect evidences of mammals. Data for birds was collected through point count method. Five points on each transect at an interval of 250 m was selected for the point count and habitat assessment. For the assessment of herpetofauna visual encounter rate method was used, in which an area or habitat was searched for 10 minutes. Data for butterflies was collected along the transect.

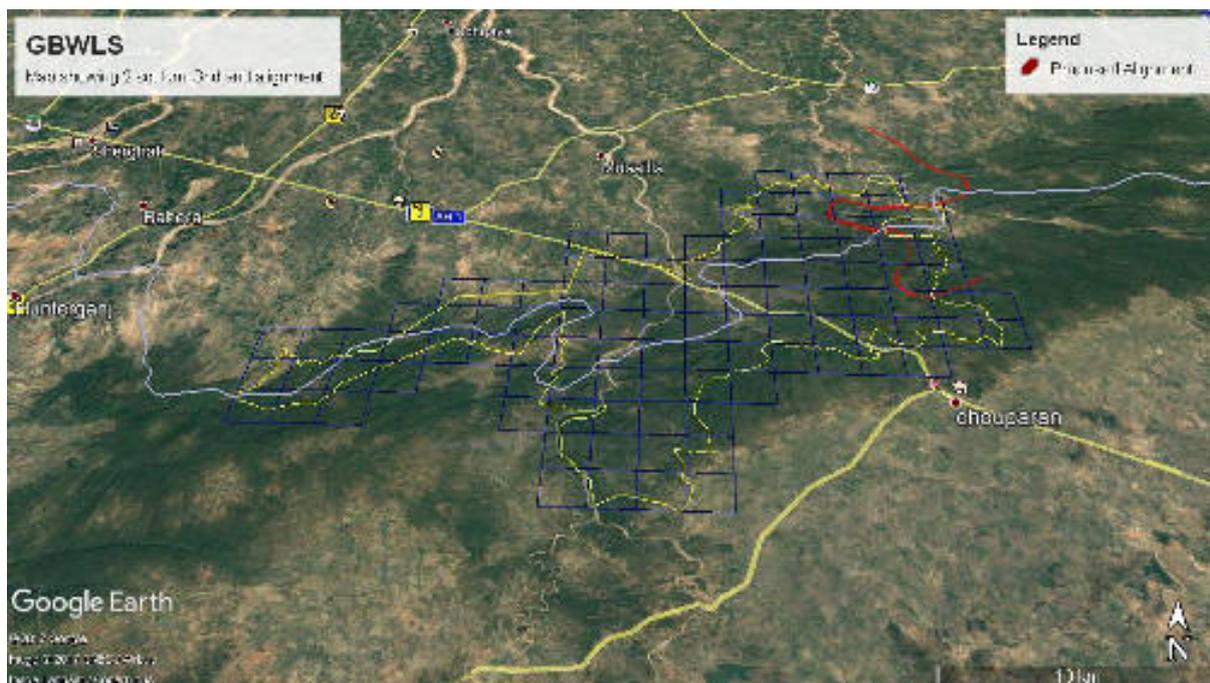


Figure 4: Map showing study area (GBWLS) divided in 2x2 km grid size.

(Source- Google Earth)

The secondary data was collected from forest departments, literature review and interaction with local people living in the forest to validate the data and get a more focussed approach in sampling. All the species recorded in the survey are assessed for Rare, Endangered and Threatened (RET) from IUCN Red List <http://www.iucnredlist.org/> for the purpose of the checklist

4.1.BIRDS: Point count method was used for birds with a single observer in each sampling point (Metcalf 2007). Point count is preferred over line transect because of undulating terrain and steep slope, monsoon season makes it difficult to walk a straight line while observing the birds (Buckland et al., 1993). Point count in which observer record bird species in a fixed or visible distance from a point in the specified time period is the widely used methods for birds density and diversity (Ralph et al., 1995, Rosenstock et al., 2002). The observation point was laid along a trail at 250 m interval and birds were recorded by using open width point count method. After reaching a point, bird count started after few minutes to let the bird's activity resume back to normal. At a point, the observer stays 10 minutes for recording the bird species. In each 1 km trail, four point of observation is selected at every 250 m distance. Bird species were identified on the basis of call and direct sighting. During point count period only birds seen were included for analysis. Birds flying and calling were excluded. At each point following parameter were recorded

- 1) Species of the birds
- 2) Group size
- 3) Sighting distance using a laser rangefinder

4.2.HERPETOFAUNA: Visual Encounter Survey (VES) was done for the survey of the amphibians and reptiles along the transect line (Manhas et al, 2016). In this method, a field personnel walks through an area or habitat for a given time period systematically searching

for animals. This method is the most widely used and is best suited to document the herpetofauna and for monitoring studies. During the systematic search, leaf litter, fallen logs, trees (bark, buttress, root and holes), shrubs, boulders, rocks and rock crevices were examined. Whenever possible, species were identified in the field. Otherwise photos were used in conjunction with reference materials including Boulanger (1890), Daniel (2002), Daniels (2005), Das (2003) and Whitaker & Captain (2004). When these resources were not sufficient to identify the species of an individual, a local researcher of wildlife institute was consulted.

4.3. MAMMALS: Mammalian diversity of the sanctuary was estimated using sign survey along the transect in the study area. Entire area was divided into 2 km² grid and in each grid transect of 1 km were laid (Buckland et al., 1993).

Presence data was recorded on the direct sighting, and indirect signs including animal dropping, territorial marking and foot marks etc.

To identify the key species area, mapping to presence location of mammals with respect to the proposed railway track was done using GIS.

4.4. BUTTERFLIES: Butterfly sampling, the most common method used for assessing butterfly abundance in monitoring programs (Newman et al., 2003) was done along the transect. This method is cost-effective and easy to implement. The drawback of this method is that it does not account for individual detection probability and temporal fragmentation of butterfly populations.

4.5. FLORA: To assess the tree diversity a quadrat plot of 10 m x 10 m at each point was laid and all trees were counted and recorded. Shrubs within the quadrat plot of 5 m x 5 m and sign of the disturbance were recorded. Data for seedling and sapling was collected within 5m x 5 m quadrat plot on the same point. For herbs and grasses, 1 m x 1m quadrat plot was laid within the 10 m x 10 m plot to record the data for vegetation (Kerbs, 1997; WII, 2011).

All the nomenclature and scientific names referred in the report followed:

Birds - Modern taxonomy J. Praveen et al. 2016 and Grimmett et al. 2011.

Herpetofauna – Daniel, 2002; Das 2002 and The Reptile Database.

Mammals – Menon, 2014 and Prater, 2005.

Butterflies – The Linnaen system of taxonomy, Butterflies of India.

Flora - Management Plan of Gautam Buddha WLS, 2008 and BSI report on GBWLS, 2016.



RESEARCH

5.1. ECOSYSTEM SERVICES AND BENEFITS

The Bihar state has only 6.87% of forest area remaining of its total geographical area (<http://forest.bih.nic.in/B-forest.aspx>). The population of Bihar is very high and per capita income is low thus the dependency of people on agriculture and natural resources is high which makes them more vulnerable to climate change. This sanctuary is one of the remaining forest patches in the southern part of Bihar and provides a multitude of ecosystem services and benefits to the area. The benefits provided by forest ecosystems include:

- Goods such as timber, food, fuel and bioproducts.
- Ecological functions such as carbon storage, soil moisture enrichment, ground water recharge, conserves rain water, nutrient cycling, water and air purification, and maintenance of wildlife habitat.
- The sanctuary harbours a number of seasonal streams, springs and headwater areas which is very significant for watershed management and also has an influence on the local climate, weather and geography.
- Social and cultural benefits such as recreation, traditional resource uses and spirituality.
- Home range for various tribes and seasonal water sources.

This forest area will play a vital role in future for climate change mitigation efforts and actions. Thus it will be early to comment on the impacts of proposed rail corridor on the economic and ecological value of forest without a dedicated and exhaustive impact assessment study of the proposed project.

5.2. BIRDS

Birds are the good indicator of ecosystem health (Koskimies 1987, 1988a), they are ecologically adaptable and live in all types of habitat (Jarvinen & Vaisanen 1979, Jarvinen 1983). In India, more than 1,340 species of birds have been identified (Ali & Ripely 1996, Manakadan & Pittie 2001). In Bihar, 582 bird species are recorded. Among them, 39 bird species are enlisted under threatened category. In Jharkhand, 448 species of bird are recorded, in which 23 species are enlisted under threatened category (birdlife international 2016). In Gaya district 331 bird species are recorded in which 15 species are threatened (BirdLife International 2001). As per the management plan of GBWLS, 93 species of bird are reported from Gautam Buddha WLS (Mishra et al, 2008).

In Bihar and Jharkhand seven Important Bird Areas (IBAs) are present (BirdLife International 2001) which are home for many residential and migratory birds. The IBAs are also important for some of the Near Threatened species. 13 threatened bird species were recorded in Bihar (BirdLife International 2001) like Black-necked Stork (*Ephippiorhynchus asiaticus*) regularly seen in Gogabil, Mokama and the Valmiki Tiger Reserve is becoming rare in India (Rahmani 1989).

To know the avifaunal diversity 27 transects of 1 km were walked with 128 sampling point was done to record the bird data. During the current study 75 bird species belonging to 44 families were recorded in which one species is endangered and one species is vulnerable under IUCN red data list.

Data collected is classified in two dataset one dataset is classified as near the proposed alignment area covering six grids and other area is covering the whole sanctuary. For the

analysis of the data PAST version 2.17c was used to evaluate species diversity (Shannon index), dominance, Simpson index, and evenness.

Table 1: Table showing diversity indices of birds in Gautam Buddha WLS.

Taxa_S	33
Individuals	305
Dominance_D	0.1166
Simpson_1-D	0.8834
Shannon_H	2.745
Evenness_e^H/S	0.4718
Equitability_J	0.7852

WHERE,

$D = \sum ((n_i/n)^2)$ where n_i is a number of individuals of taxon i .

Simpson index=1-dominance. Measures 'evenness' of the community from 0 to 1.

Shannon index (entropy). A diversity index, taking into accounts the number of individuals as well as a number of taxa.

$H = -\sum ((n_i/n) \ln(n_i/n))$

Above table (Table 1) shows the bird diversity of whole Gautum Buddha wildlife sanctuary which shows that there is no dominance of any particular species (Dominance_D=0.1166). All the species of GBWLS is evenly distributed (Simpson_1-D=0.8834). The diversity of bird of Gautam Buddha WLS is good (Shannon_H=2.745).

Table 2: Table show diversity indices of birds of proposed alignment area in GBWLS.

Taxa_S	14
Individuals	66
Dominance_D	0.1713
Simpson_1-D	0.8287
Shannon_H	2.107
Evenness_e^H/S	0.5873
Equitability_J	0.7983

Above table (Table 2) shows the bird diversity of proposed alignment area in Gautam Buddha WLS which also indicates that there is no dominance of any particular species (Dominance_D=0.1713) , all the bird species is evenly distributed (Simpson_1-D=0.8287).

Gautam Buddha WLS is a good habitat for many endangered and vulnerable faunal species. Presence of Egyptian Vulture *Neophron percnopterus* (which is endangered as per IUCN red data list) whose nesting site (Luhawar pahad) is recorded very near to the proposed alignment area within the zone of impact of the rail corridor. The number of bird species present in the sanctuary is indicative of the good potential habitat for the birds in the sanctuary, which could see a better future with more bird diversity if properly managed and protected.

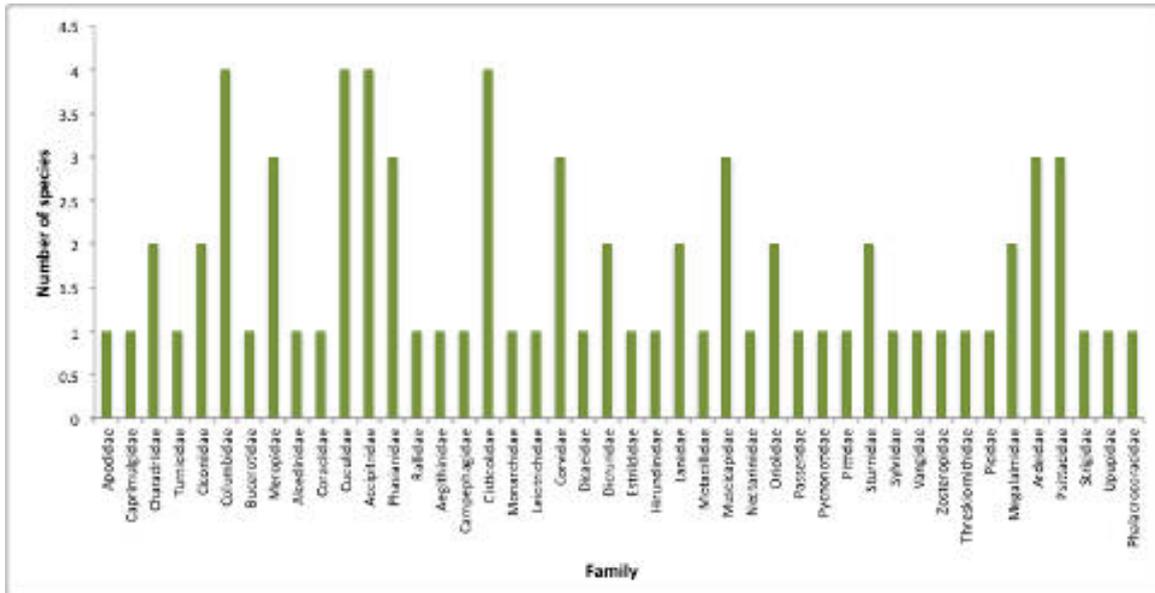


Figure 5: Histogram depicting number of species in different families of birds found in GBWLS.

The bird diversity of GBWLS belongs to 44 families of birds with highest number of species recorded from four families' viz. Cuculidae, Columbidae, Cisticolidae and Accipitridae. The sanctuary is classified into four habitat types namely mixed deciduous, dry deciduous, scrubland and village fringe. Out of all the four habitat types, mixed deciduous shows the highest number of individuals but less number of bird species in comparison to dry deciduous habitat (Fig. 6). This is indicative of species association of birds with different habitat types.

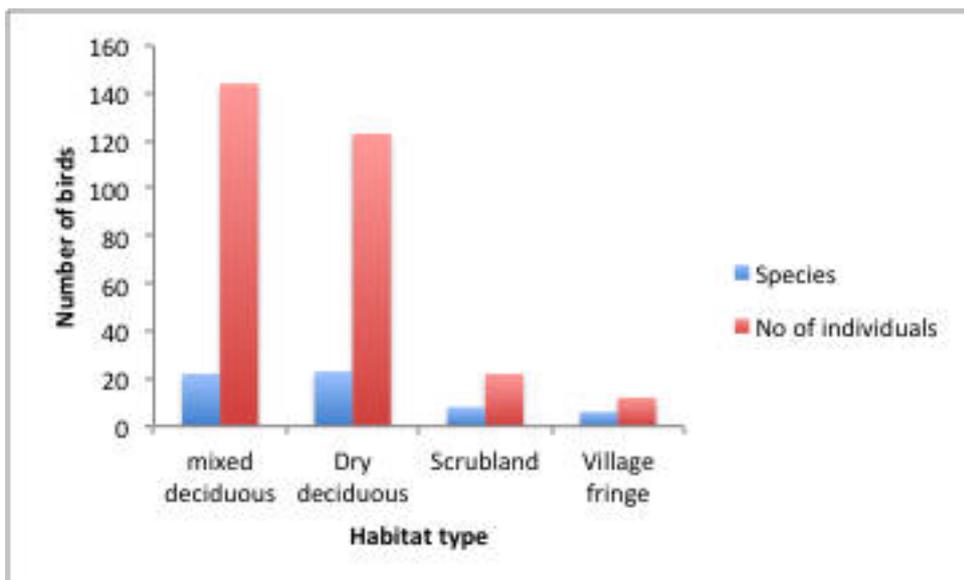


Figure 6: Graph showing distribution of bird species in different habitats type.

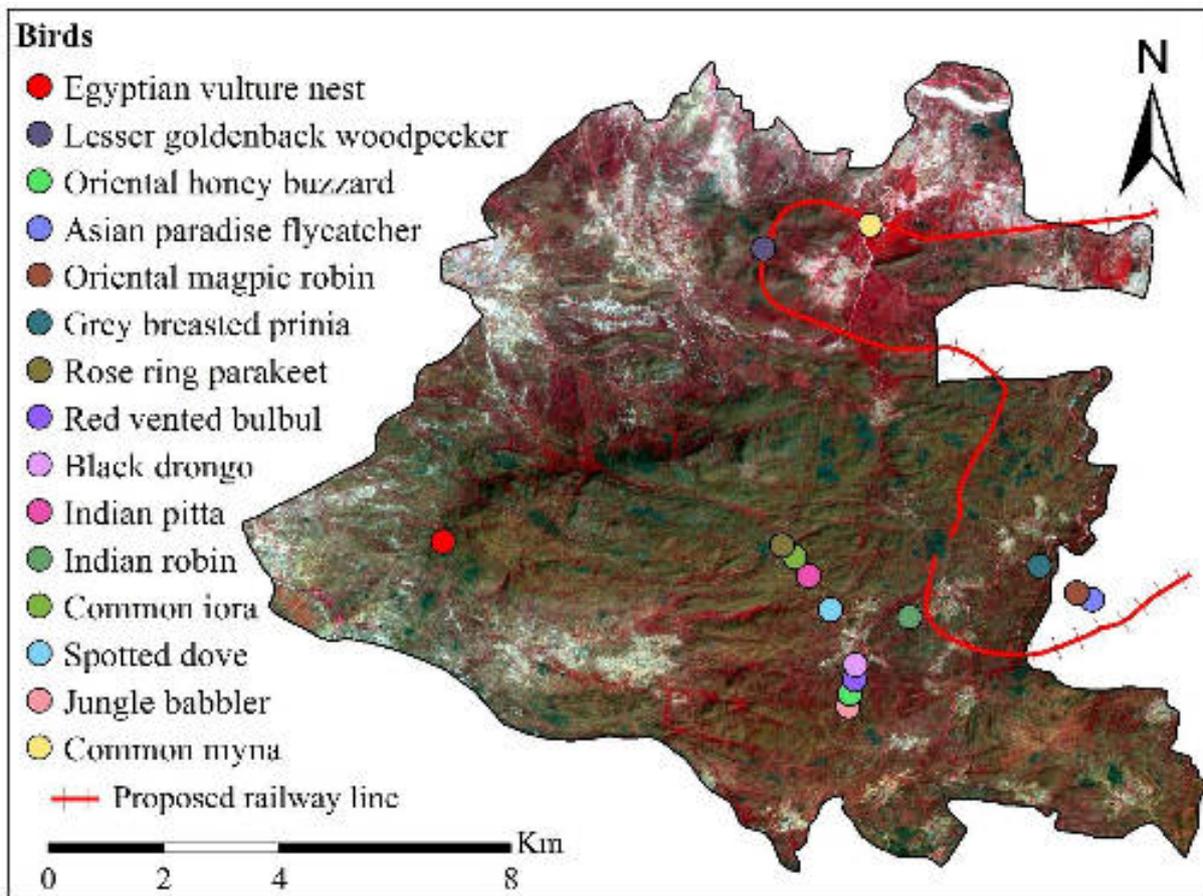


Figure 7: Map showing distribution of Bird species in the proposed Alignment area of the sanctuary.

5.3. HERPETOFAUNA

The herpetofauna perform a vital role in various food webs and act both as prey species and predator (Manhas et al 2015). Reptiles and amphibians both groups are endothermic (Cold Blooded) aquatic and terrestrial systems (Urbina-Cardona, 2008). Many herpetofauna (reptile and amphibian) species are in decline and at risk of extinction due to changes in how the land is used, which affect the environment. Amphibians are the key indicators of environmental health, which indicates the negatives changes to the environment such as habitat loss, introduced species, pollution and contaminants, pathogens, climate change, and interactions between these factors (McCallum, 2007). It is crucial that a sufficient amount of amphibian and reptilian habitat is protected to make a healthy ecosystem. Herpetofauna extinctions and extirpations (localized extinctions) occur for many reasons, including changes in land usage such as deforestation, landscape fragmentation, and landscape degradation.(Urbina-Cardona, 2008).



During the present survey, 15 species of herpetofauna which consisted of nine reptiles and six amphibians belonging to nine family were recorded (Table 3). Indian rock python (*Python molurus*) was recorded which is a Vulnerable species under IUCN Red Data List, the individual was a juvenile of Indian rock python which indicates that this species is also breeding in the sanctuary. The factors like dense foliage and vegetative growth of plants provide hiding shelter which affects the encounter rate of herpetofauna during the survey. The day time survey also did not take into account of nocturnal species of herpetofauna. Diversity of herpetofauna is relatively low in the sanctuary due to habitat loss, habitat fragmentation and degradation, high anthropogenic disturbance and lack of awareness in local people leading to snake bite and snake killing.

Presence of diverse flora and habitat type like rocks, boulder, perennial and seasonal rivers and streams provide various niche opportunities to be occupied by herpetofaunal species. River Mohane which originates from Jharkhand and passes through the Gautam Buddha WLS and many other seasonal rivers provide suitable habitats.

Table 3: Checklist of Herpetofauna in Gautam Buddha WLS.

Common Name	Scientific Name	IUCN Status	Family
Common Garden Lizard	<i>Calotes versicolor</i>	Least Concern	Agamidae
Fan Throated Lizard	<i>Sitana ponticeriana</i>	Least Concern	Agamidae
Common Indian Monitor	<i>Varanus bengalensis</i>	Least Concern	Varanidae
Rock Dragon	<i>Psammophilus dorsalis</i>	Least Concern	Agamidae
Common Water Monitor	<i>Varanus salvator</i>	Least Concern	Varanidae
Marbled Balloon Frog	<i>Uperodon systoma</i>	Least Concern	Microhylidae
Green Puddle Frog	<i>Occidozyga lima</i>	Least Concern	Dicroglossidae
Common Toad	<i>Bufo bufo</i>	Least Concern	Bufo
Indian Bullfrog	<i>Hoplobatrachus tigerinus</i>	Least Concern	Dicroglossidae
Common Skittering Frog	<i>Euphlyctis cyanophlyctis</i>	Least Concern	Dicroglossidae
Striped Burrowing Frog	<i>Litoria alboguttata</i>	Least Concern	Hylidae
Indian Rat Snake	<i>Ptyas Mucosa</i>	Not Assessed	Colubridae
Indian Rock Python	<i>Python molurus</i>	Vulnerable	Pythonidae
Checkered Keelback	<i>Xenochrophis piscator</i>	Not Assessed	Colubridae
Keeled Indian Mabuya	<i>Eutropis carinata</i>	Least Concern	Scincidae

Source: <http://www.reptile-database.org/>

5.4. MAMMALS

The previous studies of Gautam Buddha Wildlife Sanctuary suggested a rich mammalian diversity. 51 faunal species were reported in GBWLS from past studies, which include 25 mammals, 16 birds, 7 reptiles and 3 amphibians (*Kumar et. al.*, 1999). As consequence of rapidly growing human population and encroachment in and around the sanctuary area, several species of fauna have been pushed to out of the natural habitat (Kumar 1999). Anthropogenic pressures such as the exploitation of natural resources, extensive deforestation and poaching of wild fauna are the major threats to the biodiversity of GBWLS (Mishra et al, 2008). The rapid increase in livestock population and development has encroached the habitat for mammals. The pressure due to domestic stock grazing, land clearance, introduced pests (such as rabbits) or changed burning practices has led to habitat modification leading to low population of mammals (Martin 2003).

In the survey 13 mammalian species were recorded from 10 families in which only one species was in IUCN endangered list i.e. Asian elephant (*Elephas maximus*) which is Schedule 1 species under Wildlife Protection Act (WPA), 1972. This population of elephant is considered as a spillover and therefore is not the resident of the sanctuary. This evidence of elephants was recorded from southern part of the sanctuary of NH 2 (G. T. Road) which is away from the proposed alignment area of Koderma detour. During the survey two road kills were recorded one of a Jackal (*Canis aureus*) near Bagai village and other of a Jungle cat (*Felis chaus*) near Hathiya Baba Temple on NH 2.

Table 4: Checklist of the mammalian species recorded in the sanctuary.

S. NO	Common Name	Scientific Name	Family	I.U.C.N. Status
1	Golden Jackal	<i>Canis aureus</i>	Canidae	Least Concern
2	Jungle Cat	<i>Felis chaus</i>	Felidae	Least Concern
3	Asian Elephant	<i>Elephas maximus</i>	Elephantidae	Endangered
4	Spotted Deer	<i>Axis axis</i>	Cervidae	Least Concern
5	Barking Deer	<i>Muntiacus muntjak</i>	Cervidae	Least Concern
6	Blue-Bull	<i>Boselaphus tragocamelas</i>	Bovidae	Not Assessed
7	Rufous Tailed Hare	<i>Lepus negricollis</i>	Leporidae	Least Concern
8	Indian Porcupine	<i>Hystrix indica</i>	Hystriidae	Least Concern
9	Five Stripe Palm Squirrel	<i>Funambulus pennantii</i>	Sciuridae	Least Concern
10	Indian Grey Mongoose	<i>Herpestes edwardsi</i>	Herpestidae	Least Concern
11	Wild Pig	<i>Sus scrofa</i>	Suidae	Least Concern
12	Hanuman Langur	<i>Semnopithecus entellus</i>	Cercopithecidae	Least Concern
13	Rhesus Macaque	<i>Macaca mulatta</i>	Cercopithecidae	Least Concern

Source: Menon, V. (2014). *Indian mammals: a field guide* Hachette India

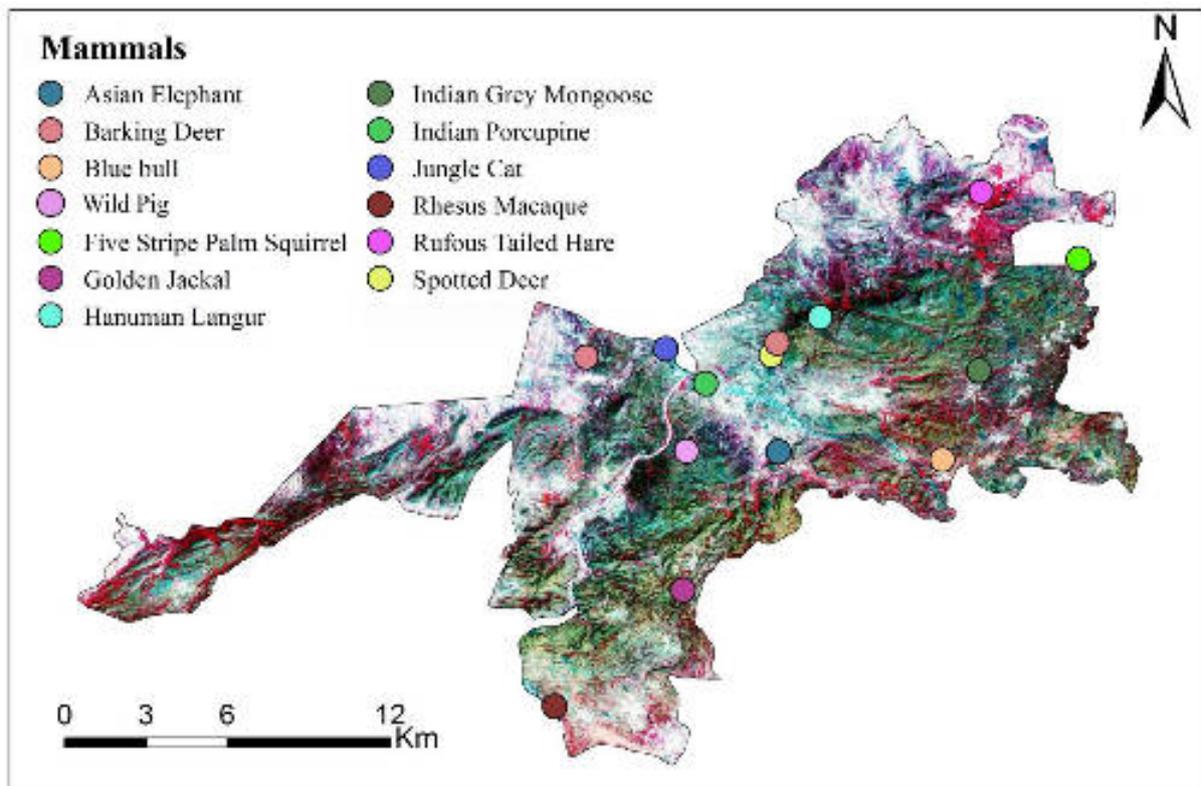


Figure 8: Map showing the locations of direct and indirect evidence of mammalian species obtained from the sanctuary.

According to the secondary data collected from the villagers during interaction the presence of Sloth Bear (*Melursus ursinus*) was confirmed in the hilly tract (Bhaura Pahad) which is located in the proposed Koderma detour alignment area. However we did not find any evidence during our short survey but the area appears to be favourable habitat for sloth bear with natural den formation of rocks due to the hilly topography of the area.

The diversity and population of mammalian species is low and sparse. The largest group of spotted deer sighted consisted of eight individuals with only one adult male. The sanctuary area is intensively grazed by livestock which appears to be a major competitor for wild herbivore population.

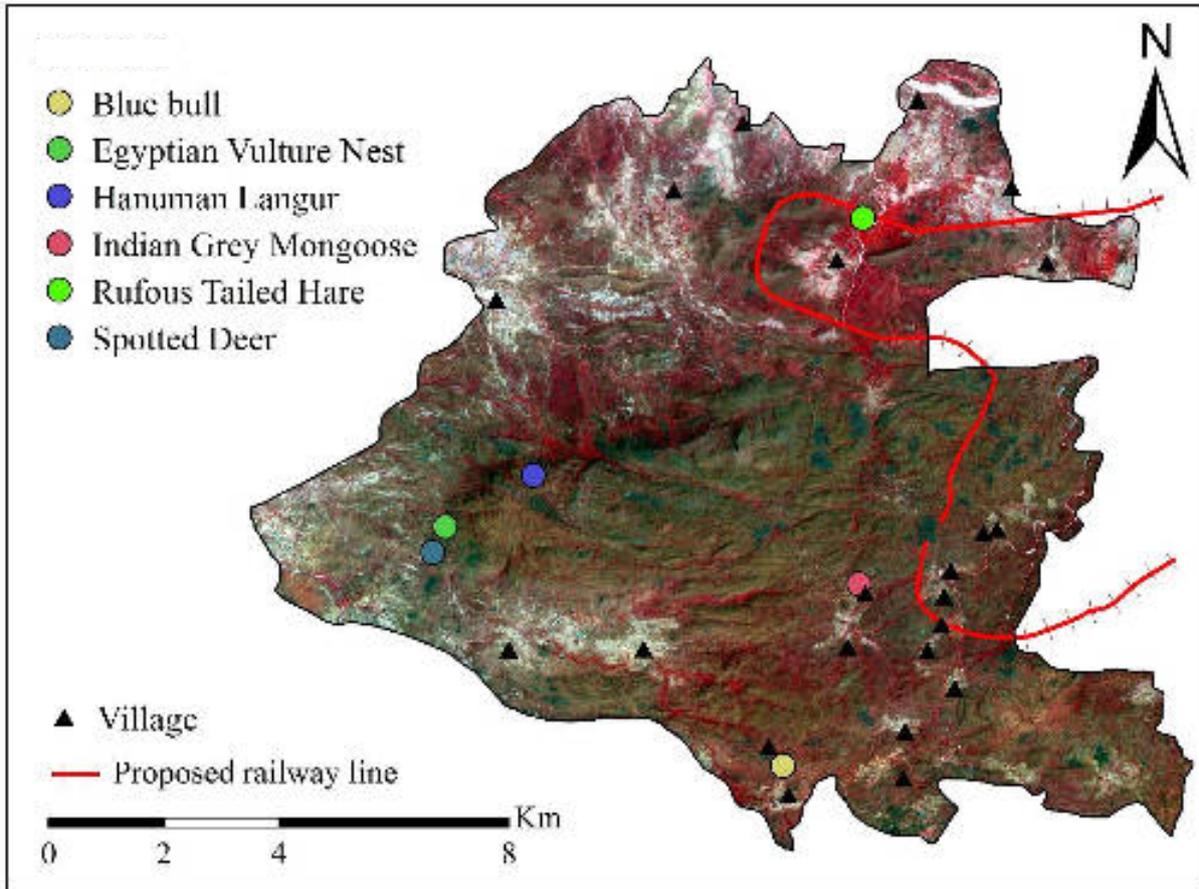


Figure 9: Map showing the distribution of Key species and villages in and around the proposed alignment area of the sanctuary based on direct and indirect evidences.

In the map above (Fig.9) the presence of key species and location of villages inside the legal boundary of the sanctuary is depicted with reference to the proposed alignment of Koderma detour.

5.5. BUTTERFLIES

The butterflies are important species for indirect measures of environmental variations as they are sensitive to micro-climate and local factors (Watt et al. 1968; Ehrlich et al. 1972; Weiss et al. 1987, 1988) Butterfly diversity may also provide surrogate measures of plant diversity because they are directly dependent on plants, often in highly coevolved situations (Ehrlich and Raven 1964). Butterflies are an important pollinators of the ecosystem which is critical for the floral diversity. The taxa has high diversity, acquires wide range of habitats and low tolerance to development makes it a suitable indicator biodiversity value of a landscape (Blair 1999).

In the survey 26 species of Butterflies and moths were recorded from five families as shown in the figure below. Only one species of moth from Eupterotidae family was recorded.

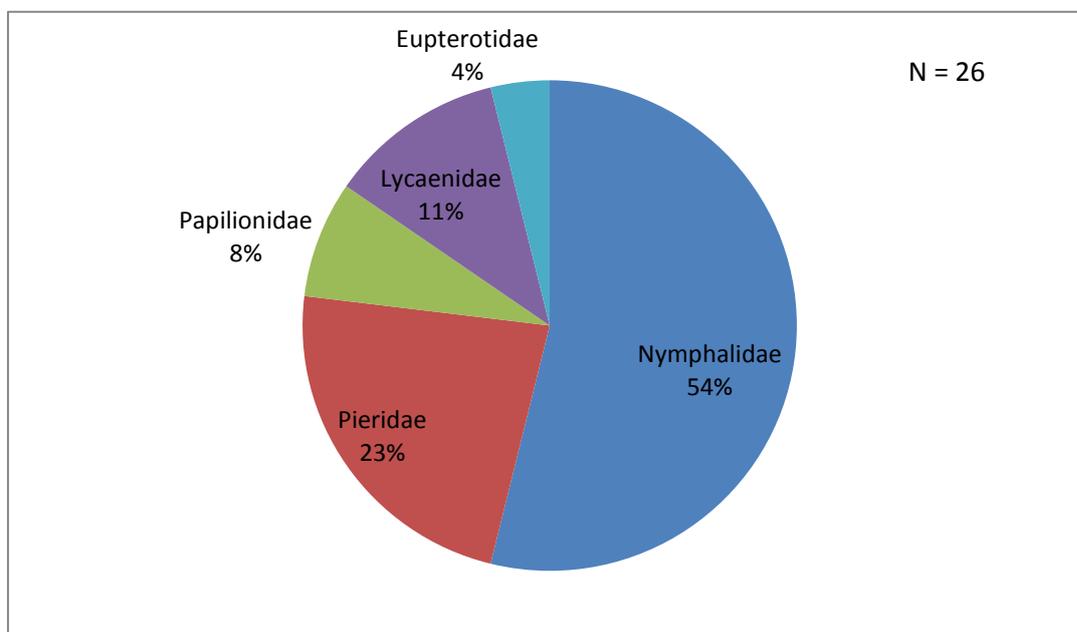


Figure 10: Butterfly families found in GBWLS.

The distribution and presence of butterflies depends on several factors like season, temperature, climatic parameters and floral diversity of the area. The figure below (Fig. 11)

shows the association of butterflies with different forest types found in the sanctuary. The sanctuary has been classified into four habitat types namely Mixed Deciduous, Scrubland, Village Fringe and Dry Deciduous.

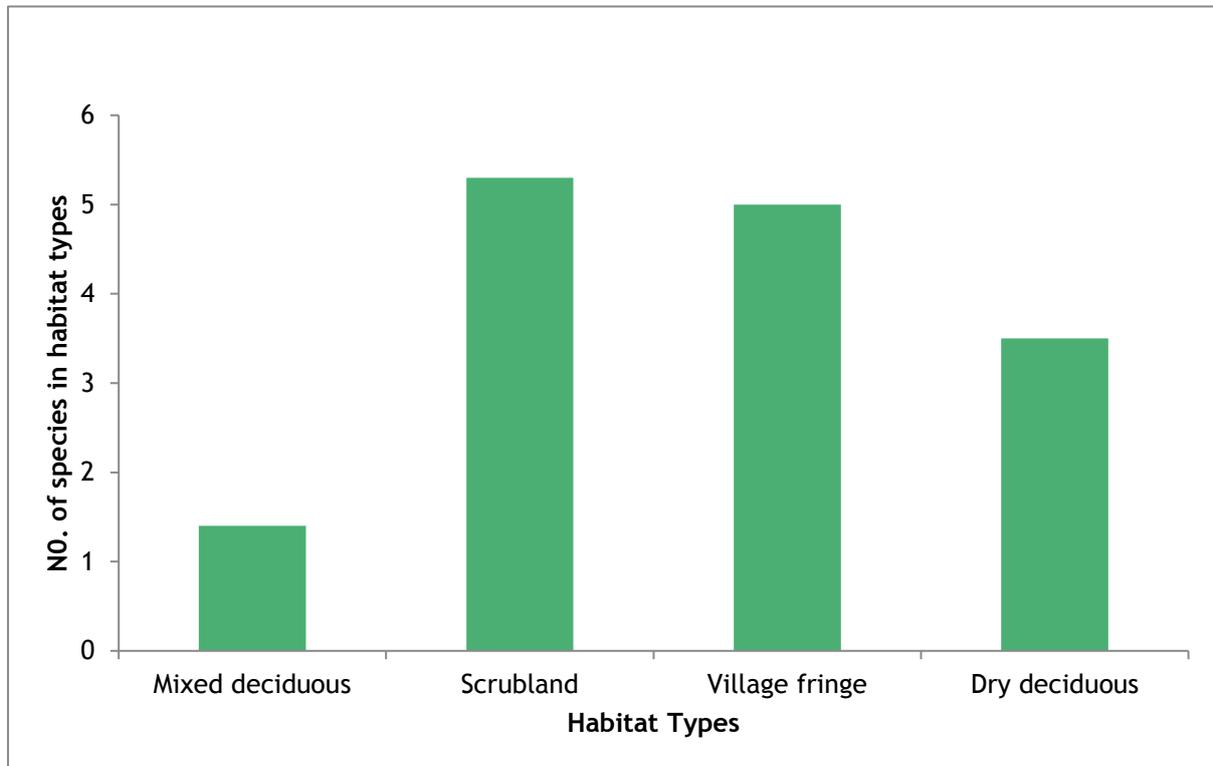


Figure 11: Different habitat types and the Lepidopteron species recorded.

The graph (Fig. 11) is indicative that the Scrubland has more diverse assemblage of butterfly species followed by village fringe, dry deciduous and mixed deciduous in descending order.

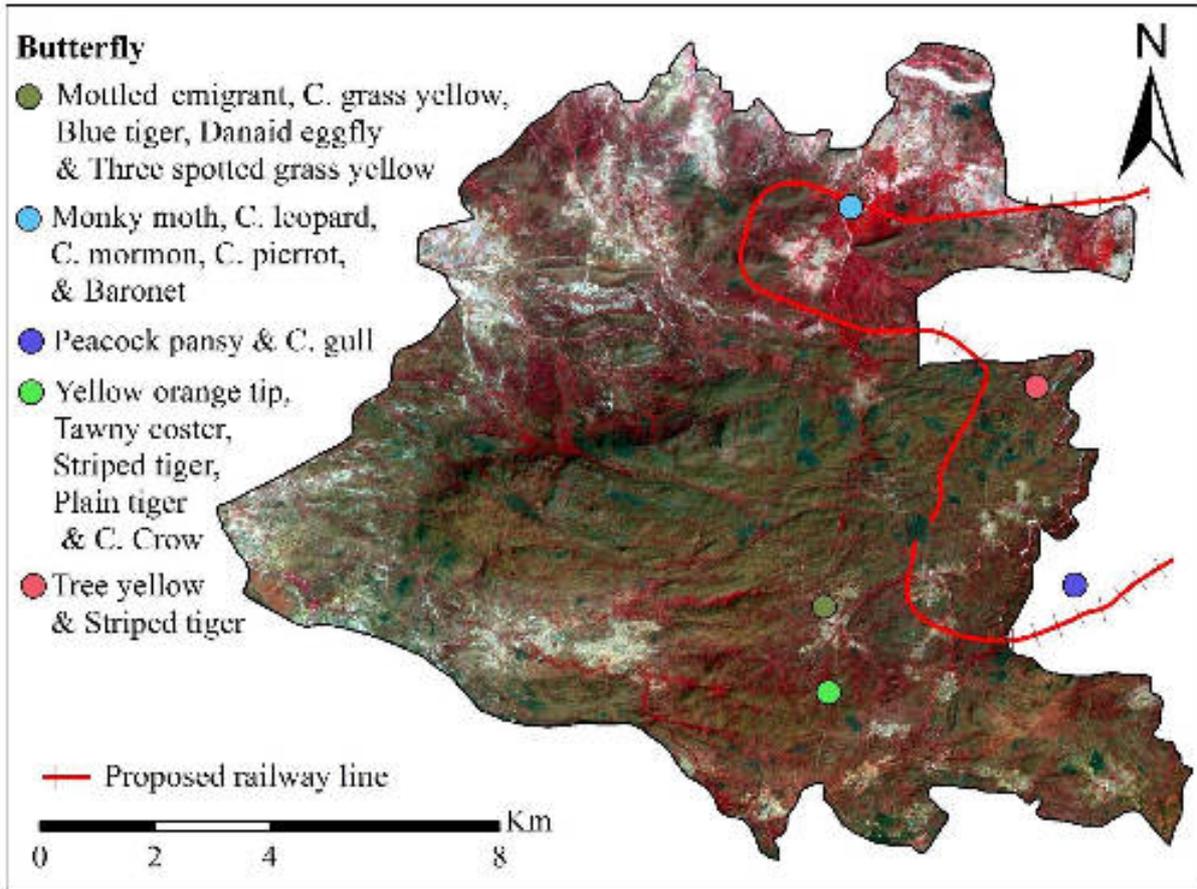


Figure 12: Map Showing the distribution of lepidopteron species observed during the survey in proposed alignment area.

5.6.FLORA

In the survey, totally 30 curvilinear transects of 1 km was walked to record the data of vegetation from 140 sample plots. Some of the plots which fell in agricultural fields near the villages in sanctuary were not assessed for the purpose of study (total 10 such plots). A total of 101 plant species were recorded from the survey transects. Among 101 species of plants, two species of trees were Vulnerable (Vu) and one Data Deficient under IUCN Red List. Amongst all the 63 species of trees recorded from the sampling plots in the sanctuary the most commonly and abundantly found species is koraiya (*Holarrhela antidysentrica*) followed by Tendu/ Kendu (*Diospyros melanoxylon*) and Sidha (*Lagerstroemia parviflora*).

The chart below shows the percentage of different types of plant species recorded during the study.

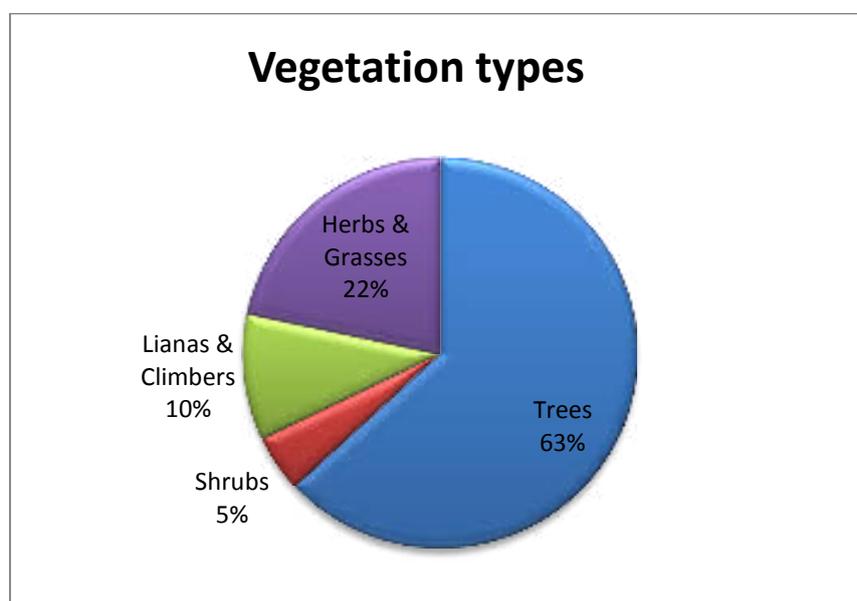


Figure 13: Graph showing the presence of different types of plants in GBWLS.

The data collected have been classified in two datasets one focussed towards the proposed alignment area of the sanctuary covering six grids and other dataset represents the whole sanctuary. For the analysis of the data PAST version 2.17c was used to evaluate species diversity (Shannon index), dominance, Simpson index and evenness (Keylock, 2005).

Table 5: The diversity indices of trees for proposed alignment area (Dataset 1).

Taxa_S	36
Individuals	456
Dominance_D	0.1064
Simpson_1-D	0.8936
Shannon_H	2.624
Evenness_e^H/S	0.3831
Equitability_J	0.7323

WHERE,

$D = \sum ((n_i/n)^2)$ where n_i is number of individuals of taxon i .

Simpson index=1-dominance. Measures 'evenness' of the community from 0 to 1.

Shannon index (entropy). A diversity index, taking into accounts the number of individuals as well as number of taxa.

$H = -\sum ((n_i/n) \ln(n_i/n))$

The table above represents the area from where the proposed alignment for Koderma detour is passing which shows that dominance of any particular tree species is not significant rather species are more evenly distributed (Simpson_1-D = 0.89). The area shows good floral diversity (Shannon_H = 2.62) with more than 50% of total species found in the sanctuary is

present in this area which is representative of only 20% area of total surveyed area. Thus it is evident that this area is rich in vegetation.

Table 6: Table showing Diversity indices of trees in Gautam Buddha WLS (Dataset 2).

Taxa_S	67
Individuals	2630
Dominance_D	0.08089
Simpson_1-D	0.9191
Shannon_H	3.02
Evenness_e^H/S	0.306
Equitability_J	0.7184

The table above represents the diversity indices of the tree species of the whole Gautam Buddha WLS which shows that there is no dominance of any particular species. All the species of trees are very well and evenly (Simpson_1-D) distributed throughout the sanctuary. The tree species diversity of Gautam Buddha WLS is good (Shannon_H = 3.02).

The presence of invasive species like *Lantana camara* in around 60% of the total sampled plots signifies the anthropogenic disturbance and interference in natural habitat of the Gautam Buddha WLS is high. But still the area has some remote pockets of potential natural forests.



5.7. HUMAN SETTLEMENTS

In biodiversity, conservation and protection role of human is very important. The anthropogenic activities in Protected Areas (PAs) and its surrounding have a significant influence on the biodiversity and health status of any forest area. In our study area we recorded the number of villages and households in and around the Gautam Buddha Wildlife sanctuary during our survey. This preliminary data of villages gives us a glimpse of anthropogenic pressure on sanctuary forest and its resources.

In the survey total 63 villages were recorded, out of which 52 villages are located inside the legal boundary of the sanctuary and 11 villages on the fringe of the sanctuary. More than 3000 households belonging to 22 Castes of Hindu and Muslims inclusive are present in the area. The largest community residing in the sanctuary is Yadav followed by Harijan and Bhuiya (Fig 14). The yadav community is largely dependent on livestock rearing and farming and on the other hand harijan and bhuiya belongs to low income community, thus their dependency on forest resources is very high. The sanctuary is dotted with number of villages inside its legal boundary with clustered density and highly degraded forest in those locations (Fig. 15). This is indicative of high anthropogenic pressure on the biodiversity of Gautam Buddha Wildlife Sanctuary.

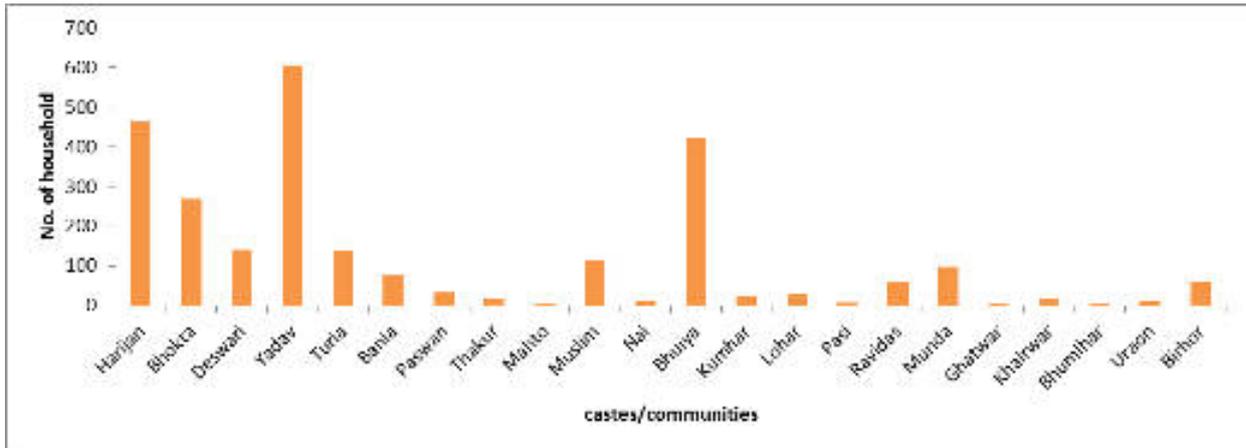


Figure 14: Histogram showing the no. of households belonging to different communities residing in the sanctuary.

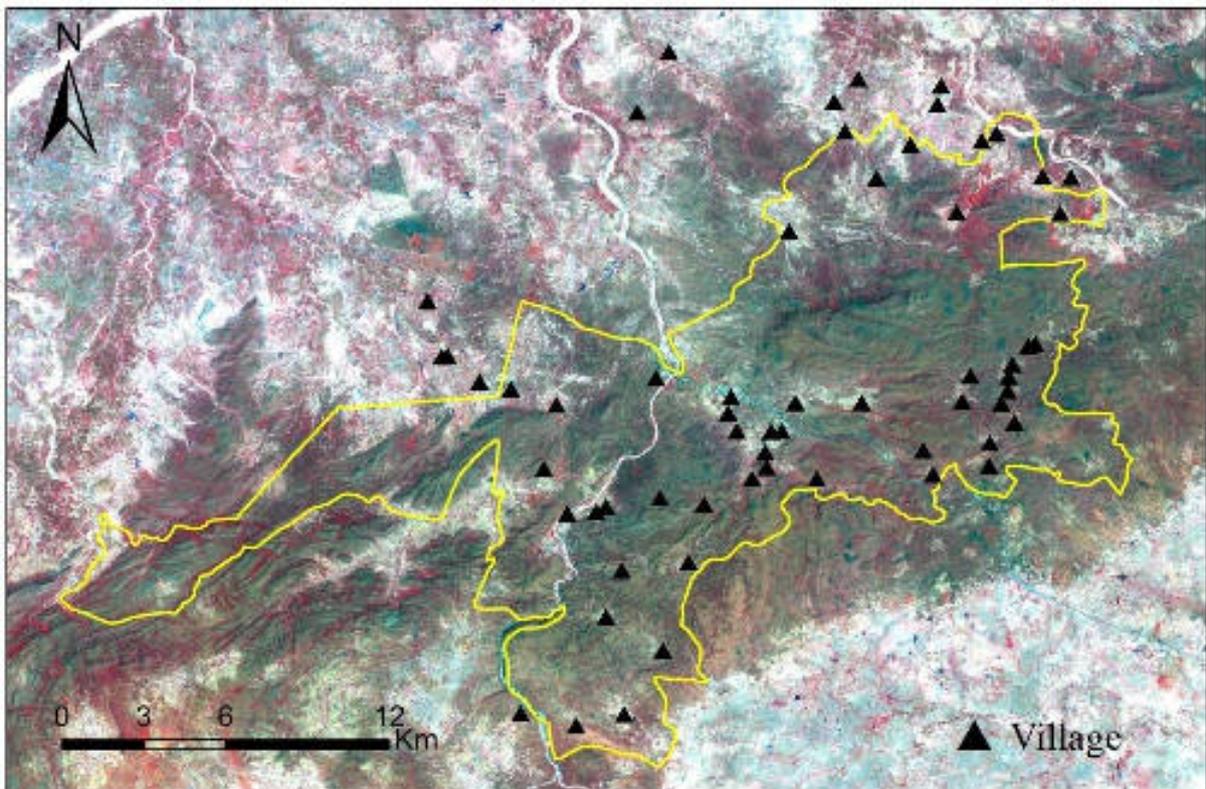


Figure 15: Map showing the locations of villages in the sanctuary and the Eco-sensitive Zone of the sanctuary.

CONCLUSION

The survey was conducted in the season of monsoon in Gautam Buddha Wildlife Sanctuary which posed some limitations like inappropriate conditions for line transect due to dense vegetative growth of the plants, remoteness of some of the forest patches and influence of left wing extremism in that area which constrained the working hours in the field. However, the study was conducted with outmost efficiency and intensity possible within the limitations.

The assessment was conducted with regard to the proposed alignment of Koderma detour of Eastern Dedicated Freight Corridor of the sanctuary. The outcome of the assessment highlights the diversity of the sanctuary with respect to flora and fauna which is good and sustainable. The condition of mammalian diversity is poor especially the large mammals.

Table 7: Checklist of Rare, Endangered and Threatened (RET) species found during survey based on direct and indirect evidences.

Common Name	Scientific Name	Family	I.U.C.N. Threat Status	WPA 1972
Indian Rock Python	<i>Python molurus</i>	Pythonidae	Vulnerable	Sch I (Part II)
Asian Elephant	<i>Elephas maximus</i>	Elephantidae	Endangered	Sch I (Part I)
Egyptian Vulture	<i>Neophron percnopterus</i>	Accipitridae	Endangered	Sch IV
Woolly-Necked Stork	<i>Ciconia episcopus</i>	Ciconiidae	Vulnerable	NL
Kala Shisham /Choland	<i>Dalbergia latifolia</i>	Leguminosae	Vulnerable A1cd ver 2.3	-
Paisar/ Vijaysal	<i>Pterocarpus marsupium</i>	Leguminosae	Vulnerable A1cd ver 2.3	-

Source: http://www.wiienvi.nic.in/Database/ScheduleSpeciesDatabase_7969.aspx



During the study, six species belonging to threatened taxa were recorded. It includes one mammal, two birds, two plants and one snake species. Namely Asian Elephant, Egyptian Vulture, Woolly Necked Stork, Paisar/Vijaysal, Kala shisham and Indian Rock Python.

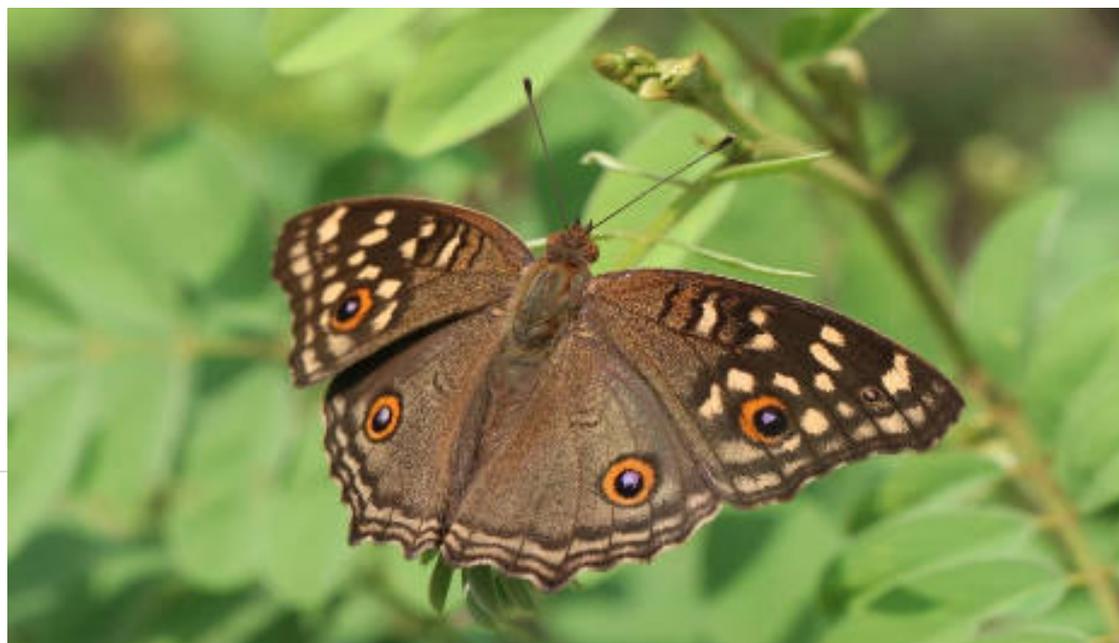
The occurrence of elephants indicated towards the diverse vegetation of the study area, as elephants are browsers and forage on a variety of plant species. Also, elephants are considered as forest architects and thus their presence is a good indicator and essential so as to maintain the vegetation diversity. The Egyptian vulture nests on cliffs of hill show the favourable habitat of this endangered species. Woolly Necked Stork species shows a preference for natural and man-made wetland habitats including rivers, streams, lakes, ponds, water-holes, lagoons, dams, floodplains, marshes, and freshwater. Kala Shisham it grows in the sub-Himalayan tract from Oudh eastwards to Sikkim, Bihar, Orissa, and throughout central and southern India. Its honey is dark amber and strong flavoured. The tannins in the bark are used for diarrhoea, worms, indigestion, and leprosy. These tannins also produce an appetizer. Paisar plant drug belonging to a group called Rasayana in Ayurvedic system of medicine are used to make a wooden tumbler from the heartwood to cure diabetes.

The sanctuary has high anthropogenic pressure and disturbance which is one of the main limiting factors for its distribution and abundance of the wildlife. The remote sensing and GIS analysis of the area also highlights the degraded state of forest and habitat. It witnesses the intentional forest fire every year in dry season for the collection of Non Timber Forest Product (NTFP).The sanctuary has the potential to rejuvenate if given proper protection and

management. The landscape provides mosaic of habitats and different niches to be occupied and sustained by various groups of animals. The present condition is not favourable for larger mammalian carnivore species diversity which may be attributed to poor prey base and excessive interference due to anthropogenic activities leading to the disappearance of homing and foraging areas for large animals.

The area of sanctuary from where the Koderma detour is proposed to pass has some existing pockets of good natural forest which is home to some important species like Sloth Bear and Egyptian Vulture. The floral diversity of those forest patches is good with some perennial rivulets draining that area. This area majorly falls in hilly tracts with remote and naturally sustained forests. The sanctuary will play a pivotal role in climate change resilience and mitigation efforts. It also influences and sustains the regional climate, topography and water resources.

The passing of the rail corridor will definitely impact the habitat and forest area which needs to be assessed for its feasibility and mitigation before the development activities starts. This study is only limited to assessment of biodiversity of both flora and fauna. The impact assessment study will involve a more intensive sampling and data collection for the area of the proposed alignment to get a better picture of its impact on the forest. The study will take 6-8 months more to assess the impact and suggest a sound mitigation and compensation plan.



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APPENDICES

APPENDIX I

Checklist of Birds recorded in Gautam Buddha Wildlife Sanctuary.

S.No.	Family	Scientific Name	Common Name	IUCN Status	Resident Status
Apodidae					
1		<i>Apus affinis</i>	Indian House Swift	Least Concern	Resident
Caprimulgidae					
2		<i>Caprimulgus asiaticus</i>	Indian Nightjar	Least Concern	Resident
Charadriidae					
3		<i>Vanellus indicus</i>	Red-Wattled Lapwing	Least Concern	Resident
4		<i>Vanellus malabaricus</i>	Yellow-Wattled Lapwing	Least Concern	Resident
Turnicidae					
5		<i>Turnix suscitator</i>	Barred Buttonquail	Least Concern	Resident
Ciconiidae					
6		<i>Ciconia episcopus</i>	Woolly-Necked Stork	Vulnerable	Resident
7		<i>Anastomus oscitans</i>	Asian Openbill	Least Concern	Resident
Columbidae					
8		<i>Streptopelia chinensis</i>	Spotted Dove	Least Concern	Resident
9		<i>Streptopelia decaocto</i>	Eurasian Collared Dove	Least Concern	Resident

10	<i>Columba livia</i>	Rock Pigeon	Least Concern	Resident
11	<i>Streptopelia senegalensis</i>	Laughing Dove	Least Concern	Resident
Bucerotidae				
12	<i>Ocyceros birostris</i>	Indian Grey Hornbill	Least Concern	Resident
Meropidae				
13	<i>Merops orientalis</i>	Green Bee-Eater	Least Concern	Resident
14	<i>Merops philippinus</i>	Blue-Tailed Bee-Eater	Least Concern	Resident
15	<i>Merops leschenaulti</i>	Chestnut-Headed Bee-Eater	Least Concern	Breeding
Alcedinidae				
16	<i>Halcyon smyrnensis</i>	White Throated Kingfisher	Least Concern	Resident
Coraciidae				
17	<i>Coracias benghalensis</i>	Indian Roller	Least Concern	Resident
Cuculidae				
18	<i>Clamator jacobinus</i>	Pied Cuckoo	Least Concern	Resident
19	<i>Hierococcyx varius</i>	Common Hawk Cuckoo	Least Concern	Resident
20	<i>Eudynamis scolopaceus</i>	Asian Koel	Least Concern	Resident
21	<i>Centropus sinensis</i>	Greater Coucal	Least Concern	Resident
Accipitridae				

22	<i>Neophron percnopterus</i>	Egyptian Vulture	Endangered	Resident
23	<i>Elanus caeruleus</i>	Black-Winged Kite	Least Concern	Resident
24	<i>Pernis ptilorhynchus</i>	Oriental Honey-Buzzard	Least Concern	Resident
25	<i>Accipiter badius</i>	Shikra	Least Concern	Resident
Phasianidae				
26	<i>Pavo cristatus</i>	Indian Peafowl	Least Concern	Resident
27	<i>Francolinus pondicerianus</i>	Grey Francolin	Least Concern	Resident
28	<i>Galloperdix lunulata</i>	Painted Spurfowl	Least Concern	Resident
Rallidae				
29	<i>Amaurornis phoenicurus</i>	White-Breasted Waterhen	Least Concern	Resident
Aegithinidae				
30	<i>Aegithina tiphia</i>	Common Iora	Least Concern	Resident
Campephagidae				
31	<i>Pericrocotus cinnamomeus</i>	Small Minivet	Least Concern	Resident
Cisticolidae				
32	<i>Prinia hodgsonii</i>	Grey Breasted Prinia	Least Concern	Resident
33	<i>Orthotomus sutorius</i>	Common Tailorbird	Least Concern	Resident

34	<i>Prinia inornata</i>	Plain Prinia	Least Concern	Resident
35	<i>Prinia socialis</i>	Ashy Prinia	Least Concern	Resident
Monarchidae				
36	<i>Terpsiphone paradisi</i>	Indian Paradise - Flycatcher	Least Concern	Resident
Leiothrichidae				
37	<i>Turdoides striata</i>	Jungle Babbler	Least Concern	Resident
Corvidae				
38	<i>Dendrocitta vagabunda</i>	Rufous Treepie	Least Concern	Resident
39	<i>Corvus macrorhynchos</i>	Large-Billed Crow	Least Concern	Resident
40	<i>Corvus splendens</i>	House Crow	Least Concern	Resident
Dicaeidae				
41	<i>Dicaeum agile</i>	Thick-Billed Flowerpecker	Least Concern	Resident
Dicruridae				
42	<i>Dicrurus macrocercus</i>	Black Drongo	Least Concern	Resident
43	<i>Dicrurus leucophaeus</i>	Ashy Drongo	Least Concern	Breeding
Estrildidae				
44	<i>Lonchura punctulata</i>	Scaly-Breasted Munia	Least Concern	Resident
Hirundinidae				
45	<i>Cecropis daurica</i>	Red-Rumped Swallow	Least Concern	Resident

Laniidae				
46	<i>Lanius vittatus</i>	Bay-Backed Shrike	Least Concern	Resident
47	<i>Lanius schach</i>	Long Tailed Shrike	Least Concern	Resident
Motacillidae				
48	<i>Anthus rufulus</i>	Paddyfield Pipit	Least Concern	Resident
Muscicapidae				
49	<i>Oenanthe fusca</i>	Brown Rock chat	Least Concern	Resident
50	<i>Copsychus saularis</i>	Oriental Magpie Robin	Least Concern	Resident
51	<i>Saxicoloides fulicatus</i>	Indian Robin	Least Concern	Resident
Nectariniidae				
52	<i>Cinnyris asiaticus</i>	Purple Sunbird	Least Concern	Resident
Oriolidae				
53	<i>Oriolus xanthornus</i>	Black-Hooded Oriole	Least Concern	Resident
54	<i>Oriolus kundoo</i>	Indian Golden Oriole	Least Concern	Resident
Passeridae				
55	<i>Passer domesticus</i>	House Sparrow	Least Concern	Resident
Pycnonotidae				
56	<i>Pycnonotus cafer</i>	Red-Vented Bulbul	Least Concern	Resident
Pittidae				
57	<i>Pitta brachyura</i>	Indian Pitta	Least Concern	Breeding

Sturnidae					
58	<i>Gracupica contra</i>	Asian Pied Starling	Least Concern	Resident	
59	<i>Acridotheres tristis</i>	Common Myna	Least Concern	Resident	
Sylviidae					
60	<i>Chrysomma sinense</i>	Yellow-Eyed Babbler	Least Concern	Resident	
Vangidae					
61	<i>Tephrodornis virgatus</i>	Large Wood-Shrike	Least Concern	Resident	
Zosteropidae					
62	<i>Zosterops palpebrosus</i>	Oriental White-Eye	Least Concern	Resident	
Threskiornithidae					
63	<i>Pseudibis papillosa</i>	Red-Naped Ibis	Least Concern	Non breeding	
Picidae					
64	<i>Dinopium benghalense</i>	Lesser Golden-backed Woodpecker	Least Concern	Resident	
Megalaimidae					
65	<i>Psilopogon haemacephalus</i>	Coppersmith Barbet	Least Concern	Resident	
66	<i>Psilopogon zeylanicus</i>	Brown-Headed Barbet	Least Concern	Resident	
Ardeidae					
67	<i>Ardeola grayii</i>	Indian Pond Heron	Least Concern	Resident	
68	<i>Egretta garzetta</i>	Little Egret	Least Concern	Resident	
69	<i>Bubulcus ibis</i>	Cattle Egret	Least	Resident	

			Concern	
Psittacidae				
70	<i>Psittacula krameri</i>	Rose-Ringed Parakeet	Least Concern	Resident
71	<i>Psittacula eupatria</i>	Alexandrine Parakeet	Least Concern	Resident
72	<i>Psittacula roseata</i>	Blossom- Headed Parakeet	Least Concern	Resident
Strigidae				
73	<i>Glaucidium radiatum</i>	Jungle Owlet	Least Concern	Resident
Upupidae				
74	<i>Upupa epops</i>	Common Hoopoe	Least Concern	Resident
Phalacrocoracidae				
75	<i>Microcarbo niger</i>	Little Cormorant	Least Concern	Resident

Source: Modern Taxonomy (J. Praveen et al., 2016)

APPENDIX II

Checklist of Butterflies and moths of Gautam Buddha Wildlife Sanctuary.

s.no	Common Name	Scientific Name	Family	IUCN threat status
1	Tawny Coster	<i>Acraea terpsicore</i>	Nymphalidae	Not Assessed
2	Blue Pansy	<i>Junonia orithya</i>	Nymphalidae	Not Assessed
3	Common Crow	<i>Euploea core</i>	Nymphalidae	Least Concern
4	Blue Tiger	<i>Tirumala limniace</i>	Nymphalidae	Not Assessed
5	Common Grass Yellow	<i>Eurema hecabe</i>	Pieridae	Not Assessed
6	Common Leopard	<i>Phalanta phalantha</i>	Nymphalidae	Not Assessed
7	Common Gull	<i>Cepora nerissa</i>	Pieridae	Not Assessed
8	Danaid Eggfly	<i>Hypolimnas misippus</i>	Nymphalidae	Not Assessed
9	Great Eggfly	<i>Hypolimnas bolina</i>	Nymphalidae	Not Assessed
10	Yellow Orange Tip	<i>Ixias pyrene</i>	Pieridae	Not Assessed
11	Lemon Butterfly	<i>Papilio demoleus</i>	Papilionidae	Not Assessed
12	Lemon Pansy	<i>Junonia lemonias</i>	Nymphalidae	Not Assessed
13	Mottled Emigrant	<i>Catopsilia pyranthe</i>	Pieridae	Not Assessed
14	Peacock Pansy	<i>Junonia almana</i>	Nymphalidae	Least Concern
15	Plain Tiger	<i>Danaus chrysippus</i>	Nymphalidae	Not Assessed
16	Striped Tiger	<i>Danaus genutia</i>	Nymphalidae	Not Assessed
17	Three Spotted	<i>Eurema blanda</i>	Pieridae	Not Assessed

Grass Yellow				
18	Common Sailer	<i>Neptis hylas</i>	Nymphalidae	Not Assessed
19	Chocolate Pansy	<i>Junonia iphita</i>	Nymphalidae	Not Assessed
20	Common Mormon	<i>Papilio polytes</i>	Papilionidae	Not Assessed
21	Common Pierrot	<i>Castalius rosimon</i>	Lycaenidae	Not Assessed
22	Spotted Pierrot	<i>Tarucus callinara</i>	Lycaenidae	Not Assessed
23	State Flash	<i>Rapala manea</i>	Lycaenidae	Not Assessed
24	Tree Yellow	<i>Grandaca harina</i>	Pieridae	Not Assessed
25	Baronet	<i>Symphaedra nais</i>	Nymphalidae	Not Assessed
26	Monky Moth	<i>Eupterote lineosa</i>	Eupterotidae	Not Assessed

Source: <http://www.learnaboutbutterflies.com/Taxonomy.htm>

APPENDIX III

Checklist of Plants recorded from Gautam Buddha Wildlife Sanctuary.

S. No.	Scientific Name	Trees (Vernacular Names)	IUCN Status	Threat	Family
1	<i>Acacia catechu</i>	Khair	Not Assessed		Fabaceae
2	<i>Adina cordifolia</i>	Karam	Not Assessed		Rubiaceae
3	<i>Aegle marmelos</i>	Bel	Not Assessed		Rutaceae
4	<i>Ailanthus excelsa</i>	Ghorkarand	Not Assessed		Simaroubaceae
5	<i>Alangium salvifolium</i>	Dhela	Not Assessed		Cornaceae
6	<i>Anogeissus latifolia</i>	Dhaw/Dhautha	Not Assessed		Combretaceae
7	<i>Azadirachta indica</i>	Neem	Not Assessed		Meliaceae
8	<i>Bauhinia racemosa</i>	Kathul	Not Assessed		Fabaceae
9	<i>Bauhinia variegata</i>	Kachnar	Least Concern Ver 3.1		Fabaceae
10	<i>Bombax ceiba</i>	Semul	Not Assessed		Malvaceae
11	<i>Boswellia serrata</i>	Salai	Not Assessed		Burseraceae
12	<i>Bridelia retusa</i>	Kaaj	Not Assessed		Phyllanthaceae
13	<i>Buchanania lanzan</i>	Piar	Not Assessed		Anacardiaceae
14	<i>Butea monosperma</i>	Palas	Not Assessed		Fabaceae
15	<i>Carissa opaca</i>	Kananda	Not Assessed		Apocynaceae
16	<i>Cassia fistula</i>	Amaltas/Dudhaur	Not Assessed		Fabaceae
17	<i>Ceriscoides turgida</i>	Karhar	Not Assessed		Rubiaceae
18	<i>Combretum decandrum</i>	Ratend	Not Assessed		Combretaceae
19	<i>Croton oblongifolius</i>	Masondha	Not Assessed		Euphorbiaceae
20	<i>Dalbergia latifolia</i>	Choland/ Shisham	Kala Vulnerable A1cd Ver 2.3		Leguminosae
21	<i>Dalbergia sissoo</i>	Shisham	Not Assessed		Leguminosae
22	<i>Diospyros melanoxylon</i>	Tendu	Not Assessed		Ebenaceae
23	<i>Diospyros montana</i>	Makar Kendu	Not Assessed		Ebenaceae
24	<i>Ehretia laevis</i>	Datrang	Not Assessed		Boraginaceae
25	<i>Elaeodendron kamerunense</i>	Ratalgadu/Khaura	Data Deficient Ver 3.1		Celastraceae

26	<i>Erythrina variegata</i>	Farhad	Least Concern Ver 3.1	Leguminosae
27	<i>Ficus bengalensis</i>	Bargad	Not Assessed	Moraceae
28	<i>Ficus hispida</i>	Kath Dumar	Not Assessed	Moraceae
29	<i>Ficus racemosa</i>	Gular	Not Assessed	Moraceae
30	<i>Ficus religiosa</i>	Peepal	Not Assessed	Moraceae
31	<i>Flacourtia indica</i>	Behcha	Not Assessed	Salicaceae
32	<i>Gardenia gummifera</i>	Bandarlaud	Least Concern Ver 2.3	Rubiaceae
33	<i>Garuga pinnata</i>	Kaikar	Not Assessed	Burseraceae
34	<i>Gmelina arborea</i>	Gamhar	Not Assessed	Lamiaceae
35	<i>Helicteres isora</i>	Aintha	Not Assessed	Malvaceae
36	<i>Holarrhela antidysentrica</i>	Koraia	Not Assessed	Malvaceae
37	<i>Hymenodictyon excelsum</i>	Bhurkund	Not Assessed	Rubiaceae
38	<i>Ixora arborea</i>	Khonta	Not Assessed	Rubiaceae
39	<i>Lagerstroemia parviflora</i>	Sidha	Not Assessed	Lythraceae
40	<i>Lagerstroemia spp.</i>	Sikith	Not Assessed	Lythraceae
41	<i>Lannea coromandelica</i>	Parmhi	Not Assessed	Anacardiaceae
42	<i>Madhuca indica</i>	Mahua	Not Assessed	Sapotaceae
43	<i>Mallotus phillipensis</i>	Rori	Not Assessed	Euphorbiaceae
44	<i>Melia azadirachta</i>	Buccane	Not Assessed	Meliaceae
45	<i>Miliusa velutina</i>	Kari	Not Assessed	Annonaceae
46	<i>Nyctanthes arbortristis</i>	Samsihar	Not Assessed	Oleaceae
47	<i>Ougeinia oojeinensis</i>	Panan	Not Assessed	Fabaceae
48	<i>Phoenix acaulis</i>	Khajur	Not Assessed	Arecaceae
49	<i>Prosopis cineraria</i>	Shami	Not Assessed	Fabaceae
50	<i>Pterocarpus marsupium</i>	Paisar	Vulnerable A1cd Ver 2.3	Leguminosae
51	<i>Schleichera trijuga</i>	Kusum	Not Assessed	Sapindaceae
52	<i>Semecarpus anacardium</i>	Bhelwa	Not Assessed	Anacardiaceae
53	<i>Shorea robusta</i>	Sal	Least Concern Ver 2.3	Dipterocarpaceae
54	<i>Streblus asper</i>	Sihora	Not Assessed	Moraceae
55	<i>Syzygium cumini</i>	Jamun	Not Assessed	Myrtaceae

56	<i>Syzygium spp.</i>	Chamarber	Not Assessed	Myrtaceae
57	<i>Tamarindus indica</i>	Imli	Not Assessed	Fabaceae
58	<i>Terminalia arjuna</i>	Kahua	Not Assessed	Combretaceae
59	<i>Terminalia belerica</i>	Bahera	Not Assessed	Combretaceae
60	<i>Terminalia tomentosa</i>	Asan	Not Assessed	Combretaceae
61	<i>Ziziphus nummularia</i>	Ber	Not Assessed	Rhamnaceae
62	<i>Ziziphus spp.</i>	Kakor	Not Assessed	Rhamnaceae
63	<i>Ziziphus xylopyrus</i>	Katar	Not Assessed	Rhamnaceae
S. No.	Scientific Name	Shrubs (Vernacular Names)	IUCN Status	Threat Family
1	<i>Acacia megaladana</i>	Arar (Lianas)	Not Assessed	Fabaceae
2	<i>Bauhinia Vahlia</i>	Mahulan (Climber)	Not Assessed	Fabaceae
3	<i>Butea superba</i>	Dhodharan (Lianas)	Not Assessed	Fabaceae
4	<i>Cassytha filiformis</i>	Amarlata	Not Assessed	Lauraceae
5	<i>Catunaregam spinosa</i>	Emun/Mauna	Not Assessed	Rubiaceae
6	<i>Combretum album</i>	Latur (Climber)	Not Assessed	Combretaceae
7	<i>Lantana camara</i>	Putus	Not Assessed	Verbenaceae
8	<i>Luffa cylindrica</i>	Turiya (Climber)	Not Assessed	Cucurbitaceae
9	<i>Momordica charantia</i>	Jungli Karela	Not Assessed	Cucurbitaceae
10	<i>Momordica dioica</i>	Kheksa (Climber)	Not Assessed	Cucurbitaceae
11	<i>Mucuna pruriens</i>	Alkusi	Not Assessed	Fabaceae
12	<i>Ventilago denticulata</i>	Ramai (Lianas)	Not Assessed	Rhamnaceae
13	<i>Vitex negundo</i>	Sinhuar	Not Assessed	Lamiaceae
14	<i>Ziziphus oenoplia</i>	Dithora	Not Assessed	Rhamnaceae
S. No.	Scientific Name	Herbs/Grasses (Vernacular Names)	IUCN Status	Threat Family
1	<i>Abrus precatorius</i>	Gaithi (Climber)	Not Assessed	Fabaceae
2	<i>Achyranthes aspera</i>	Sevtar	Not Assessed	Amaranthaceae
3	<i>Ageratum conyzoides</i>	Jungli Pudina	Not Assessed	Amaranthaceae
4	<i>Andropogon intermedius</i>	Ghusi	Not Assessed	Poaceae
5	<i>Andropogon pumilus</i>	Rusi	Not Assessed	Poaceae
6	<i>Argemone mexicana</i>	Rangaini Kanta	Not Assessed	Papaveraceae
7	<i>Blumea lacera</i>	Kukraundha	Not Assessed	Asteraceae
8	<i>Cajanus scarabaeoides</i>	Van Kurthi	Least	Leguminosae

Concern Ver 3.1				
9	<i>Chrysopogon aciculatus</i>	Sama Ghas	Not Assessed	Poaceae
10	<i>Clerodendrum infortunatum</i>	Titbhant	Not Assessed	Lamiaceae
11	<i>Ichnocarpus frutescens</i>	Dudhlar	Not Assessed	Apocynaceae
12	<i>Cyathocline purpurea</i>	Jirhul Ghas	Least Concern Ver 3.1	Compositae
13	<i>Cynadon dactylon</i>	Dub	Not Assessed	Poaceae
14	<i>Cyperus rotundus</i>	Motha	Least Concern Ver 3.1	Cyperaceae
15	<i>Dactyloctenium aegyptium</i>	Makra Ghas	Not Assessed	Poaceae
16	<i>Dendrocalamus strictus</i>	Bamboo	Not Assessed	Poaceae
17	<i>Elettaria cardamomum</i>	Basaria	Not Assessed	Zingiberaceae
18	<i>Ocimum canum</i>	Van Tulsi	Not Assessed	Lamiaceae
19	<i>Phyllanthus Niruri</i>	Van Jira/Bhumi Amla	Not Assessed	Phyllanthaceae
20	<i>Pueraria tuberosa</i>	Patakohda	Not Assessed	Fabaceae
21	<i>Senna occidentalis</i>	Saharfoka	Not Assessed	Fabaceae
22	<i>Senna tora</i>	Chakauda	Not Assessed	Fabaceae
23	<i>Sida cordifolia</i>	Bariyar	Not Assessed	Malvaceae
24	<i>Urginea indica</i>	Vanpyaj	Not Assessed	Liliaceae

Source: Management Plan of Hazaribagh (Mishra et al., 2008)

APPENDIX IV

Village Names situated in and around the Gautam Buddha Wildlife Sanctuary.

S.No.	Village Name	GPS Coordinates Latitude (N) Longitude (E)
1	Phungunia	24 25 21.69 85 05 57.17
2	Piprahi	24 24 46.64 85 08 15.05
3	Dwat	24 26 38.29 85 06 11.97
4	Somia-kewalia	24 26 56.82 85 05 18.08
5	Jaigeer	24 27 05.79 85 04 40.75
6	Gowaria	24 27 35.73 85 03 55.74
7	Chittaghadha Regua	24 30 05.81 85 10 48.29
8	Mangura	24 32 28.26 85 07 48.03
9	Kusa tand	24 33 40.25 85 08 25.56
10	Ramchak	24 32 05.19 85 11 54.35
11	Kewla	24 32 41.22 85 11 41.62
12	Siddhagadha	24 33 07.79 85 12 10.22
13	Kunhiatari	24 33 00.19 85 13 48.51
14	Machrak	24 32 02.50 85 14 54.06
15	Rangaini	24 31 11.59 85 15 48.53
16	Bagai	24 31 10.49 85 16 22.42
17	Tangaini	24 30 27.26 85 16 09.40
18	Sarne	24 30 27.26 85 16 09.40
19	Sankhwa	24 24 30.52 85 06 59.30
20	Simratari	24 24 36.77

		85 07 10.77
21	Chotkichapi	24 24 28.13 85 0625.02
22	Bhaluachatti	24 27 10.30 85 08 10.30
23	Chordaha	24 26 47.64 85 0939.23
24	Dibahi	24 26 28.66 85 09 35.94
25	Tetaria	24 26 06.83 85 09 46.31
26	Bherari	24 25 23.24 85 10 21.47
27	Kadarchunan	24 31 09.52 85 12 31.68
28	Bardag	24 31 49.14 85 13 0012
29	Jhurang	24 32 37.41 85 13 43.92
30	Harakhura	24 31 53 91 85 14 36.58
31	Dibo	24 30 28.62 85 14 06.77
32	Jamuniatari	24 24 39.16 85 09 07.35
33	Garmorwa	24 26 41.92 85 14 13.08
34	Parsaghat	24 25 25.14 85 14 45.43
35	Kothodumar	24 25 52.40 85 14 46.37
36	Pathalgadwa	24 26 17.79 85 15 15 43
37	Dhamanchumma	24 26 39.80 85 14 59.57
38	Mainukhar	24 26 55.06 85 15 07.52
39	Parsada	24 27 11.69 85 15 0911
40	Gulliyar	24 27 26.70 85 15 13.01
41	Gurmahwa tand	24 27 48.62 85 15 32.13
42	Bukar	24 27 51.08 85 15 40.11
43	Sanjha	24 25 15.23 85 13 38.45
44	Dhanua	24 25 43.90 85 13 26.89
45	Purni Ahri	24 26 40.50 85 10 55.70
46	Navadih	24 26 40.79

		85 12 14.13
47	Salodar	24 26 06.76 85 10 39.52
48	Baniatad & Tenduwahi	24 26 06.33 85 10 26.81
49	Chhotki Murtiya	24 25 41.58 85 10 19.94
50	Murtiya	24 25 26.24 85 10 37.68
51	Aajan	24 25 09.76 85 11 21.00
52	Tilakdih	24 27 13.35 85 14 23.19
53	Dhodiya	24 23 29.82 85 08 48.44
54	Sikdha	24 23 20.00 85 07 29.62
55	Duragadha	24 21 44.13 85.08 18.56
56	Morainia	24 22 24.64 85 07 11.06
57	Harraiya	24 28 41.91 85 03 39.06
58	Ranganiatad	24 27 36.73 85 04 02.97
59	Gowaria & Jaigeer	24 27 36.73 85 04 02.97
60	Armedar	24 20 29.09 85 05 29.53
61	Pathalgadda	24 20 28.24 85 07 32.16
62	Modiya	24 20 15.07 85 06 35.37
63	Kavilar	24 25 10.09 85 10 04.15

APPENDIX V

Plate 1: Birds of GBWLS.



Asian Paradise Flycatcher



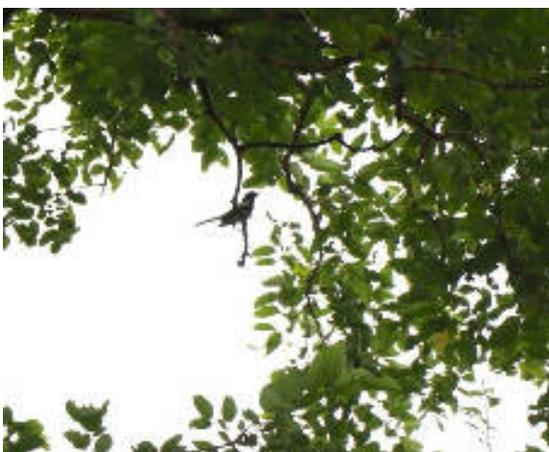
Long Tailed Shrike



Black Hooded Oriole



Greater Coucal



Oriental Magpie Robin



Jungle Babbler



Indian Roller



Chestnut-headed Bee-eater



Grey Brested Prinia



Jacobin Cuckoo



Red Vented Bulbul



Indian Pitta



Grey Francolin



Common hoopoe



Woolly-necked stork



Asian openbill



Yellow-wattled Lapwing



Indian Pond Heron



Alexandrine Parakeet



Jungle Owlet



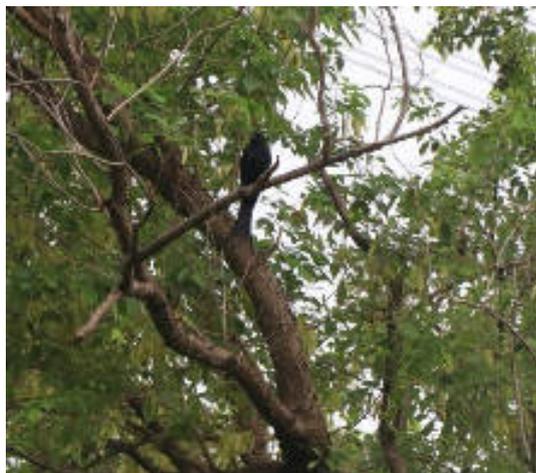
Black-winged Kite



Shikra



Yellow Eyed Babbler



Black Drongo

APPENDIX VI

Plate 2: Hepetofauna of GBWLS.



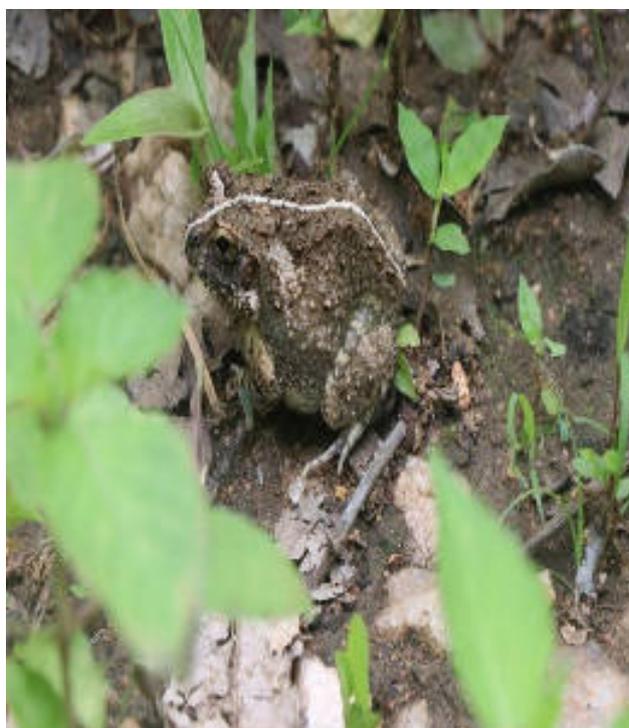
Rock Dragon



Indian Rat snake



Garden Lizard



Striped Burrowing frog



Common water Monitor



Common Indian monitor



Common Water Monitor (Yearling)



Common Skink

APPENDIX VII

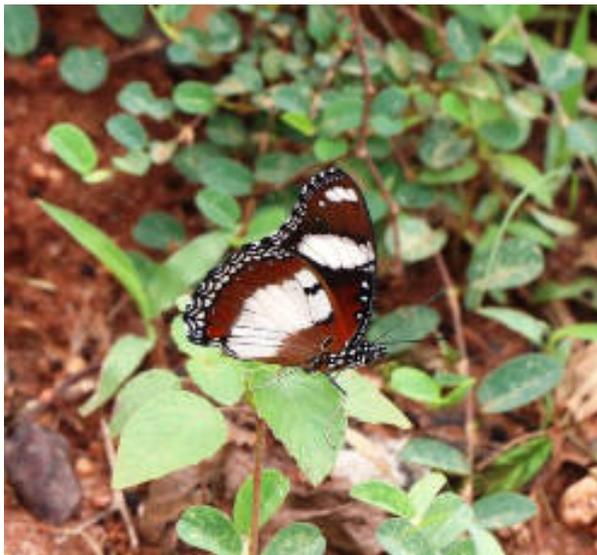
Plate 3: Butterflies of GBWLS



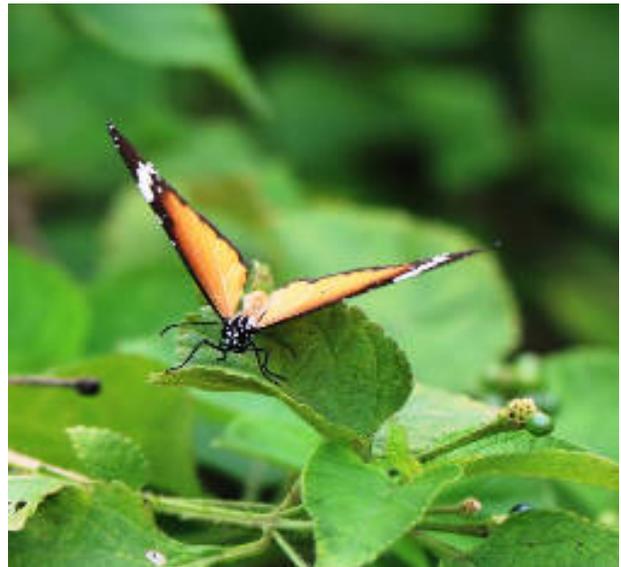
Baronet



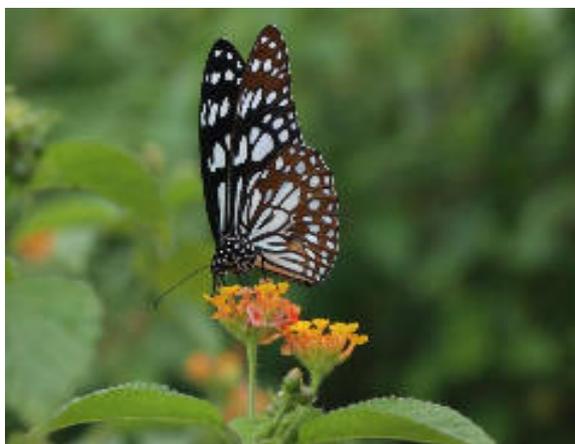
Common Leopard



Danaid Eggfly



Plain Tiger



Blue tiger



Common crow



Common Gull



Great Eggfly



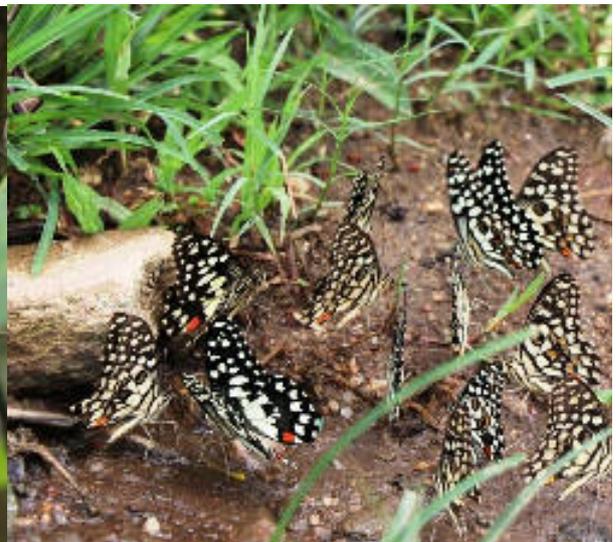
Mottled Emigrant, yellow orange tip



Blue Pansy



Tawny coster



Lemon Butterfly



Common Pierrot



Spotted Pierrot



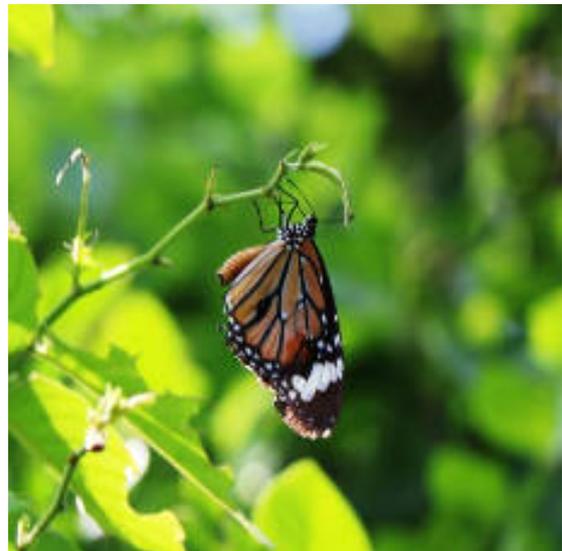
Lemon Pansy



Monkey Moth



Peacock Pansy



Striped Tiger

APPENDIX VIII

Plate 4: Landscape and disturbances of GBWLS.



River Mohane Passing through the Sanctuary, Perennial river.



Degraded Forest Landscape



GBWLS Landscape from where Koderma detour is proposed.



Stream from proposed area. Originates from the sanctuary.



Dhodiya village Inside the Sanctuary



Livestock rearing and Grazing in the Sanctuary



Data collection and sensitization of local people



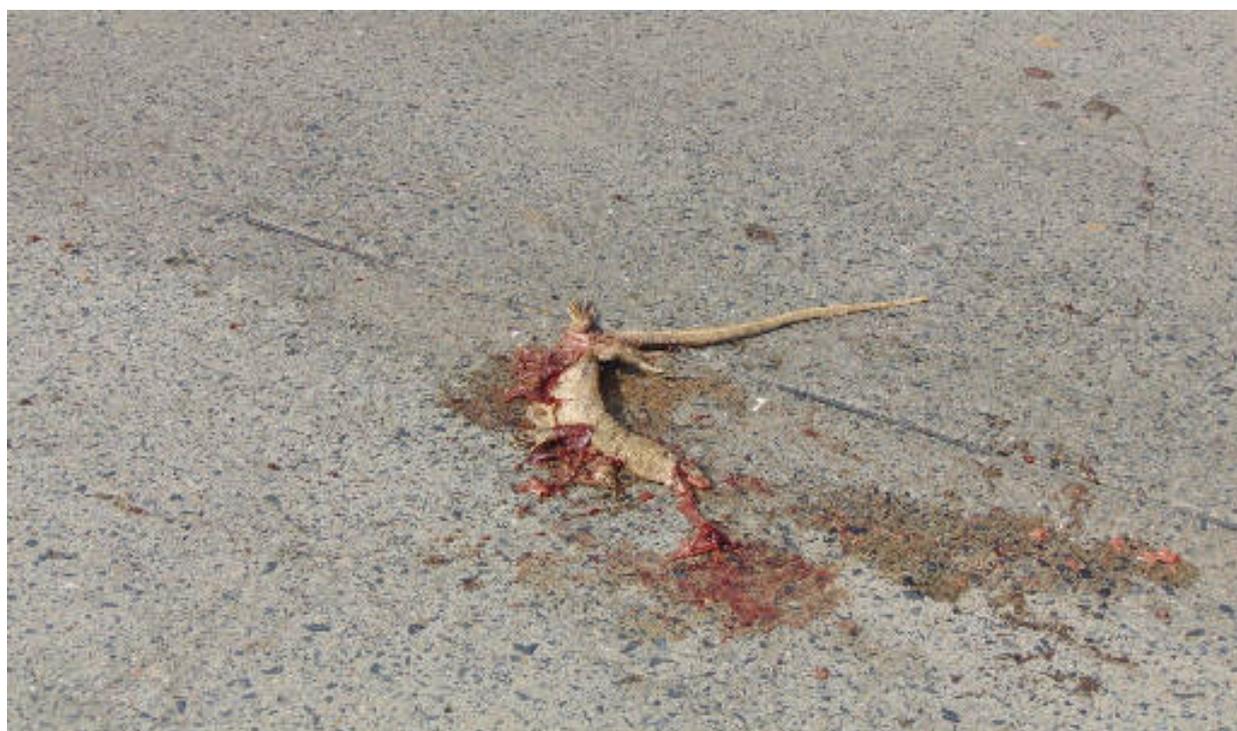
Data collection and interaction with local people

APPENDIX IX

Plate 5: Tragedies of GBWLS



Road kill (G.T. Road) of Jungle cat



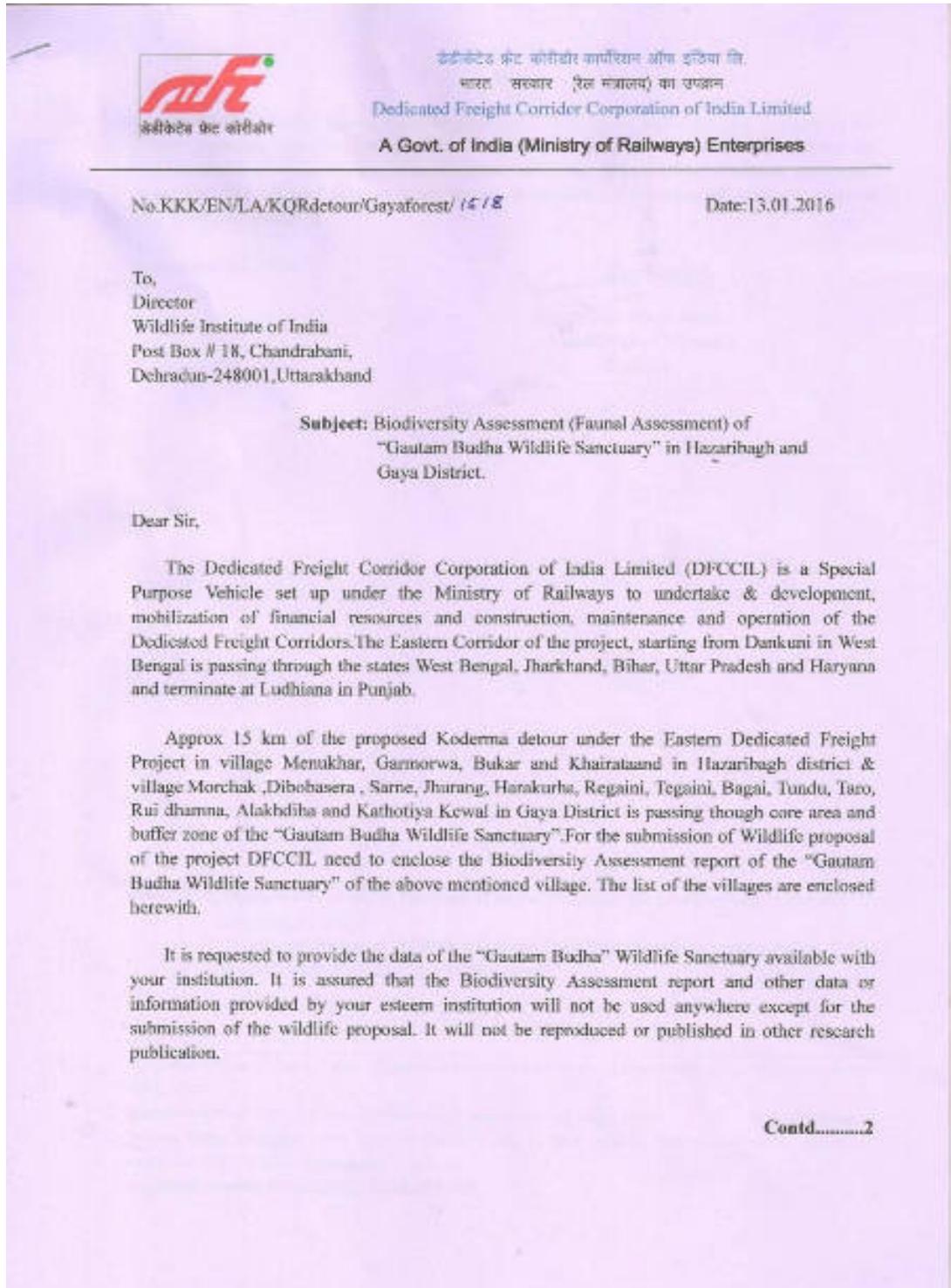
Road kill (G.T. Road) of Common Monitor Lizard



Road kill of Golden Jackal



Cutting of trees in GBWLS



:2:

DFCCIL is a time bound national project of Ministry of Railways and is listed in the priority agenda of Hon'ble prime Minister's office. Therefore, it is requested to prepare the Biodiversity Assessment report (Faunal assessment) of the "Gautam Budha wildlife sanctuary" at earliest. The required charges if any for the preparation of Biodiversity Assessment report may kindly be intimated.

Enclosures- As above


(Syed Md. Jamil Ahsan)
Chief Project Manager
Kolkata

Copy to: 1. Dean, FWS, Wildlife Institute of India, Dehradun for necessary action. E-mail: rawntp@wii.gov.in
2. In-charge, National Wildlife Database Cell, Dehradun for necessary action.
E-mail: nwdc@wii.gov.in, jsk@wii.gov.in

Corporate Office: 5th Floor, Pragati Maidan Metro Station Complex, New Delhi- 110001. Tele: 011-23454700 Fax: 011-23454701

Registered Office: Room No.101A Rail Bhawan, Raisina Road New Delhi- 110001

Web: dfccil.org

Project Office (Kolkata): 18/N (Ground Floor), Block A, New Alipore, Kolkata - 700053, Telefax - 91-33-23973937, Mail - dfcc.kolkata@gmail.com

Corporate Identity No.U60232DL2006GO115506

ANNEXURE 2

Bharat Jyoti
APCCF-cum-Chief Wildlife Warden, Bihar

Government of Bihar
O/o PCCF, Bihar (Wildlife Wing)
4th Floor, Aranya Bhawan
Shahid Pir Ali Khan Marg,
P.O.-Veterinary College, Patna 800014
email: cwlbihar@resiffmail.com
Mob. : 08986153134

No. Wildlife- 2804 Date- 08-05-17

To,

Sri G. S. Rawat
Scientist G
Wildlife Institute of India
Dehradun-248001

E-mail

Sub: Permission to carry out the field research in Gautam Buddha Wildlife Sanctuary.

Sir,

With reference to your request letter dated 20.04.2017, permission to carry out the field research and related studies for "Biodiversity Assessment" in Gautam Buddha Wildlife Sanctuary, Gaya is granted under section 28 of Wildlife (P) Act, 1972 for the period of 08.05.2017 to March 2018 with following conditions :-

Conditions for Permission:-

- 1) No activity violating the provision of Wildlife (Protection) Act, 1972 shall be done by the members of the study team and their assistants etc. The study team and their assistants etc. are expected to get themselves familiar with the provisioning of Wildlife (Protection) Act, 1972 (especially sections 12, 17 and 27 and other relevant sections). Any violation will attract provisions of the Act and strict action may be taken. The applicant will be solely responsible for the same.
- 2) The field work shall be conducted with the necessary precautions against disturbance to wildlife and adverse impact to the wildlife habitats.
- 3) List of persons along with their identity shall be submitted to the Divisional Forest Officer, Gaya along with the details of visit plan and intimation of entry inside sanctuary in advance.
- 4) Photography etc. and collection of samples shall be done in consultation with Divisional Forest Officer, Gaya, and details of the same shall be furnished to the DFO.
- 5) If the study team and their assistants etc. during their visits come across any activity/ information important from the wildlife conservation and management point of view, the same shall be reported to the Conservator of Forests, Gaya and Divisional Forest Officer, Gaya.

Yours faithfully

Bharat 8/5/17

Addl. Principal Chief Conservator of Forests
-cum-Chief Wildlife Warden, Bihar, Patna

LIST OF TABLES

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