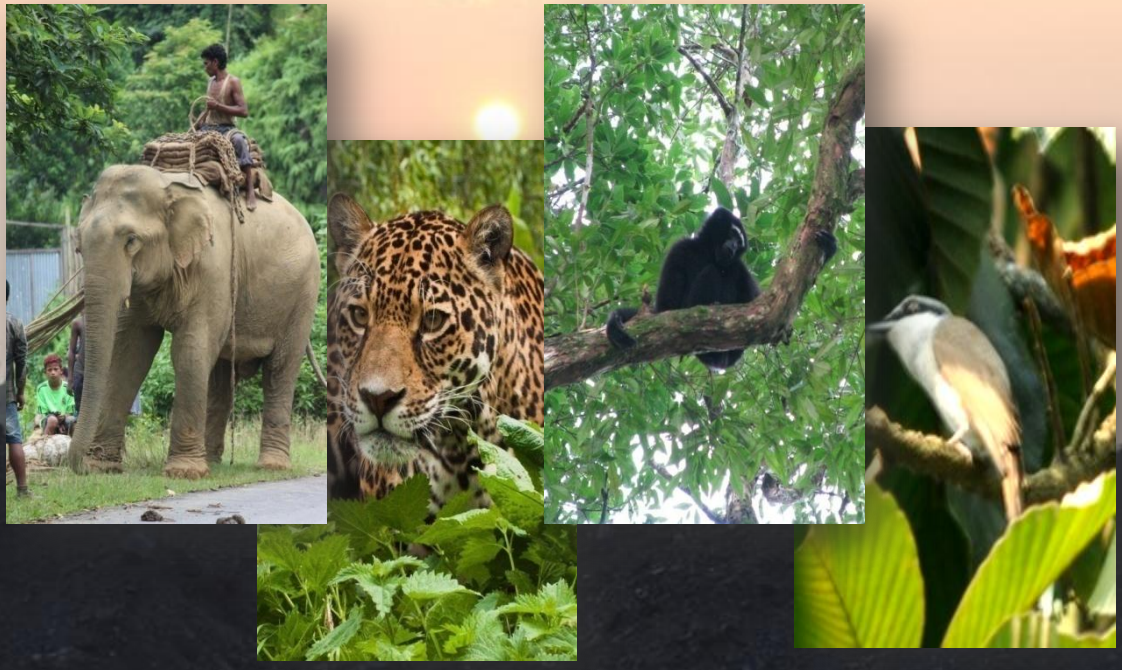
Annexure - 7

Regional Wildlife Plan

for the Makum Coalfield in Assam



Rain Forest Research Institute

(Indian Council of Forestry Research and Education)

Jorhat-785010, Assam

www.rfri.icfre.gov.in

2017

Regional Wildlife Plan

for the Makum Coalfields in Assam

Under the Project: Preparation of Biodiversity Management Plan, Regional Wildlife Plan and Carrying capacity Study for the Makum Coalfields in Assam.

Funding Agency: North Eastern Coalfields, Coal India Ltd.

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Preface

Coal is one of the prime sources of nonrenewable energy in India. Coal India Limited (CIL) is the largest coal producer company in the world, and contributes about 82% of coal production in India. North Eastern Coalfields (NEC) is a unit of CIL operating coal mines in Assam and Meghalaya. The Coalfields of Assam are situated in the biodiversity rich areas of Upper Brahmaputra Valley. Since mining has considerable impact on biodiversity, there is an urgent need for actions that promote the conservation and sustainable use of the region's natural resources, balancing the needs of conservation and development.

Rain Forest Research Institute was involved in the preparation of biodiversity management Plan for the Makum coal fields in Assam for the Assam Forest Department as stipulated in the "in-principle" approval for diversion of forest land at Tikak extension and Lekhapani open cast project of North Eastern Coalfields for coal mining, granted by the Ministry of Environment, Forest and Climate Change, Government of India as a prerequisite for providing stage II approval. The objectives also included preparation of a Regional Wildlife Management Plan for the region covering 10 km buffer zone of Makum Coal fields within Assam.

This Regional Wildlife Management Plan proposes actions that can enable different stakeholders to better protect and manage the surrounding forest as well as wildlife in and around coal mines, mainly focusing on the key species, viz., elephant, hoolock gibbon, and leopard. The forests around the mining sites are critical not only from biodiversity or wildlife perspective but also due to the fact that it regulates hydrological flows of nearby watersheds. Maintenance of life support systems is vital and the biodiversity management approach described here is based on ecological principles, and the underlying assumption is that all the major components of biodiversity and ecological processes, including the key wildlife species are likely to be maintained, if the suggested approach is followed.

(Dr. R. S. C. Jayaraj, IFS)
Director, RFRI

Acknowledgement

At the outset we would like to place our sincere gratitude to Director General, ICFRE for his continuous support and encouragement for successful completion of the Project. Mr. Jugal Kumar Borah, General Manager, North Eastern Coalfields, Coal India Ltd. is duly thanked for funding the project along with logistic and other support provided during the project tenure. Thanks are also due to the PCCF (HoFF) and PCCF (Wildlife), Assam Forest Department for their support.

The Director, Forest Research Institute, Dehradun is duly thanked for sparing the respective scientists for specialized study. The conservator of forests, Eastern circle, Jorhat and Divisional Forest Officer, Digboi Forest Division, Assam State Forest Department along wth all their staffs are also duly thanked for their continuous support. Thanks are also due to all the Range officer and support staff of Lekhapani, Jagun and Margherita range for their assistance during the field visit. We sincerely thank Mr. S. P. Dutta, General Manager (Operation), Mr. Malay Das, Area Manager (EMLR), and Mr. S. Bhattacharjee, Area Manager (Env. & Forest), North Eastern Coalfields, Coal India Ltd. for the help they extended during the project period.

Thanks are due to Amity Institute of Wildlife Sciences, NOIDA for their valuable expert's comments and suggestions on fauna of Makum coal field area. We would like to thank Dr. A. P. Singh, Scientist E, and Dr. P. K. Verma, Scientist B, from FRI, Dehradun for their valuavle inputs.

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We are deeply obliged to the local people of Margherita, Lekhapani and Jagun and the villagers of the nearby area for their whole hearted cooperation and constant involvement during the entire field study without which the study would not have been possible. Last but not the least, the services rendered by all officers and staff of Rain Forest Research Institute are also acknowledged with thanks.

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Executive Summary

Regional Wildlife Management Plan provides the appropriate framework and guidelines for conservation of wildlife population of a region. Preparation of Regional Wildlife plan has been made for the region covering 10 km buffer zone of Makum Coal fields falling within the state of Assam, with a baseline study on key flora and fauna. Wildlife management requires periodic monitoring of flora, fauna and environment. Monitoring generally does not need to update the full data set gathered during the baseline studies. In most cases, management is concerned with trends rather than absolute values and similar attempts were made in the present study.

Bio-geographically, Makum coal fields is situated in the Eastern Himalayan province, the richest bio-geographical province of the Himalayan zone and also falls in one of the biodiversity hotspots of the world. Makum Coal field area and its 10 km buffer zone falls in Digboi Forest Division, Assam covering an area of 484.8 km^2. Wholly or partly, 16 reserve/proposed reserve forests belonging to four ranges, namely Lekhapani, Jagun, Margherita East and Margherita west, fall in this buffer zone. A number of water bodies including two major rivers namely, Burhi Dhing and Tirap flow through the study area. The forest of the study area predominantly comes under under-Type IB/C1 Assam Valley Wet Evergreen Forest (Champion and Seth, 1968) or more commonly known as Upper Assam *Dipterocarpus–Mesua* formation with interspersed Tropical Semi-evergreen Forests and bamboo brakes. The common species includes *Dipterocarpus retusus* (Hollong), *Artocarpus chama* (Sam), *Shorea assamica* (Mekai), *Tetramelia nudiflora* (Bhelu), *Teminalia myriocarpa* (Hollok) etc. Situated at the confluence of the Indo-Malayan, Indo-Chinese and Indian bio-geographical realms, the region is unique in providing a profusion of habitats, which features diverse biota with a high level of endemism.

The study area was categorized under major land use/cover classes. 52.3% of the area is coming under forest cover. Moderately Dense Forests with an area of 16,256 ha covers the maximum area followed by Open Forests (7,049 ha) and Very dense forests (2,070 ha). Among the other land uses, Agriculture with an area of

10,373 ha is the dominant land use followed by Scrub land (2994 ha) and Tea gardens (2,941 ha).

Historically, the area was reported to be habitat of Capped langur (*Trachypithecus pileatus*), Hoolock gibbon (*Hoolock hoolock)*, Leopard *(Panthera pardus*), Leopard cat (*Prionailurus bengalensis*), Barking Deer *(Muntiacus muntjak*), Small Indian civet (*Viverricula indica*), Wild boar (*Sus scrofa*), Indian flying fox (*Pteropus giganteus*), three striped squirrel (*Funambulus palmarum*) and Hoary bellied squirrel (*Callosciurus pygerythrus*). The present population status and habitat occupancy of target mammalian species (Elephant, Leopard and Hoolock Gibbon) and avifauna along with other prey species were estimated based on standard methodology (direct and indirect signs and camera trapping etc.).

The study on density and distribution of Asian elephant was carried out in 15 transects of 3-4 km each in various Reserve/proposed Reserve Forest. Block count method was used exclusively as direct count method, and line transect method for both direct and indirect methods of estimating population density in the study areas. The survey work revealed that there were no elephants permanently residing in these forest areas but as this area is a part of Dihing Patkai Elephant Reserve, Elephants are found using some of Reserve forest as their part of migratory corridors. There are three elephant corridors in Digboi Forest Division, namely Golai-Pawai, Bogapani and Kotha-Burhidihing elephant Corridor.

For leopard and other larger animals camera trapping effort of an average of 21 trap nights in different Reserve Forests was done. However no photos of leopard could be captured. Various indirect evidences (hoof mark and pellets) were collected other prey bases including ungulates. The relative significance of wild ungulates in the study area was calculated using a regression model that related prey biomass and leopard density to estimate the ecological carrying capacity of the forested area. Prey sign encounter rate were calculated from Transect walk and the available prey biomass for leopard was estimated 37.2 kg/km^2. It was estimated that based on survey results on prey abundance, the available prey biomass in the forest is very low and can support only 3-4 leopards in the study area. However, since there are reports of man-leopard conflict in the area, and indirect evidence of presence of a larger number,

it can be assumed that the leopards are dependent not just on the forest prey, but also on the domestic animals, which is a potential reason for conflicts.

For Hoolock Gibbon, modified line transects method in a stratified random manner was followed for the survey, depending on the habitat and the forest condition. Call-count method was followed and collection of secondary information relevant to the study was done. Not less than 14 groups of Hoolock Gibbon were found in various forests of the study area.

The bird population was recorded using the belt transect method where the observer recorded data on the sightings of bird species, number of individuals sighted at perpendicular distance of 20 m from the line at which the species was sighted. A total of 168 bird species were recorded in the study area, 5 of which were found endemic to northeast India, 54 species are 'breeding residents' in the study area while one species is a breeding 'summer migrant' and 8 species are 'altitudinal winter migrants' from adjoining hills of Arunachal Pradesh. One species, the Common Hill Myna (*Gracula religiosa*) is listed in Schedule I Part III of the Indian Wildlife (Protection) Act, 1972.

The result shows that besides the presence of major species (Elephant, Leopard, Hoolock gibbon and avifauna), 27 major reptile species were found in the study area along with 6 amphibians. A total of 144 butterfly species were also recorded. The survey also recorded floral species of 220 trees, 102 shrubs, 122 herbs, 37 orchids, 32 Pteridophytes, 65 bryophytes, 34 macro-fungi and 23 lichens.

The major Wildlife Conservation issues along with their mitigative strategies and recommendations are summarized below:

- Fragmentation and habitat degradation: Most part of the study area, forest fringe areas in particular, were found undergoing tremendous habitat degradation resulting in forest fragmentation. Afforestation/ reforestation in degraded areas along with maintenance and strengthening of existing corridors is required to be done with immediate effect.
- Illegal felling and Firewood collection: Provisions for alternate energy sources for the local communities should be made and plantation of fuelwood species in homesteads and agriculture lands as well as the use of alternate energy sources should be promoted

- Shifting Cultivation: Awareness programme among the tribes regarding ill effect of shifting cultivation along with popularization of feasible alternative livelihood options should be encouraged
- Invasive plants: Invasive weeds should be eradicated and removed from the natural forests in a phased manner by mechanical or manual uprooting followed by immediate sowing of grasses.
- Encroachment: A Wildlife Task Force (WTF) may be created with close association and participation of the local people and forest department.
- Unauthorized mining: Action should be taken to tackle unauthorized mining through strengthening the law and order machinery and through creating awareness among the local people.
- Soil and water related issues: Site specific remedial measures like check dams, rock fill dams, gully plugging, planting of native grass species etc. should be implemented.
- Poaching: Poaching areas should be identified and checklist of habitual offenders should be prepared.
- Infrastructure and manpower related issues like lack of trained manpower, insufficient infrastructure for protection staff and the need for their capacity building are discussed at length in the report.
- Socio-economic and other management issues like participation of stakeholders in planning, dependence of people on forest, human wildlife conflict, lack of awareness among local people and field staff, and formation of Eco-development Committees are also discussed at length.
- The budget of the regional wildlife plan was merged with Biodiversity Management plan as many of the activities are overlapping in nature.

Chapter 1
Introduction

1.1 General

A well-developed and managed forest area offers a number of Ecosystem goods and services to the society. Forests play a significant role in the social and economic development of rural society and contribute to the quality of life of the people. Planning and management of protected areas was accorded its due status in scientific forest management since the time of its inception in India. One of the main objective of the region specific management plan is to protect, conserve and improve the habitat attributes for survival of the endangered and threatened faunal species such as Hoolock Gibbon, Asian elephant, Leopard, Clouded Leopard etc. and other animals along with plants, and to develop eco-tourism in and around the protected areas to engage a part of the forest fringe population to earn their livelihood. The plan also accommodates priority areas for infrastructure development along with research on the floral and faunal diversity for better management of wildlife and its habitat. It also ensures suitable conservation measures for significant flora and fauna of ecological importance for that region.

Active management of habitats to benefit wildlife populations is a fundamental concept of wildlife biology and a Regional Wildlife Management Plan is of great importance in this regard. Regional Wildlife Management Plan provides the appropriate framework and guidelines for conservation of Wildlife population of a region. The ecological baseline framework serves as a benchmark against which management-induced changes can be identified and measured. However, it is important to note that future monitoring generally does not need to update the full data set gathered during the baseline studies. In most cases, management is concerned with trends rather than absolute values. Absolute values (total number

of species, densities, etc.) are generally not needed on a day-to-day basis. Changes in relative indices of these parameters (trends) will provide the information that would be the initial baseline for any future management endeavor. For fulfilling these objectives, the current status of Key wildlife species of Makum Coal field areas i.e. Elephant, Hoolock Gibbon, Leopard and Avifauna were enumerated from primary and secondary data/ information sources.

1.2 Objective

The objective of the present venture is preparation of Regional Wildlife Plan for the region covering 10 km buffer zone of Makum Coal fields falling within the state of Assam.

1.3 Study Area

The leasehold area of North Eastern Coalfields (NEC) covers forest and non-forest areas amongst hilly terrains within Digboi Forest Division. Within these areas lie different coal mining sites. Coal mining activities of NEC, Coal India Limited (CIL) are at present confined to Makum Coalfield in Tinsukia district of Assam. NEC with its head office at Margherita is running six coal mines i.e. Baragolai, Tipong, Ledo, Tirap, Tikak and Ledo in Assam. The Coalfields cover an area of 2688.16 hectares under mining leases of Lekhapani-Tipongpani Mining lease (1158.46 Ha), Tirap Coal grant (238 Ha), 4 square-mile mining lease (1034.34 Ha), Namdang Coalgrant (156.36 Ha) and Ledo OCP mining lease (101 Ha). Baragolai Coal mine is one of the oldest underground mines operating under the Makum Coalfields of NEC, Margherita, Assam. The Tirap, Tikak and Ledo open cast mines are at present the only coal producing open cast mines in Makum Coalfields.

1.4 Statement of Significance

The Wildlife of the study area must have been rich both in diversity and number as the area forms a part of the larger Dihing Patkai Landscape, but currently not as rich as it once used to be. Faunal elements reported in the past include the species of Chinese sub-region of the Oriental Zoo-Geographical region and also the elements of the Indian Sub-region (Kakati, 2009). This area also has record of a large variety of migratory birds which breed in the North of the Sino-

Himalayan area. The area was rich with wide variety of Herbivores like Sambar, Hog deer, Barking deer, Wild Boar etc. Over the years, unfortunately their numbers have dwindled due to illegal hunting, expansion of human habitation and clearance of forest areas for settlement and other purposes. However, wildlife is still there, though their numbers have dwindled considerably.

Bio-geographically, the study site is situated in the Eastern Himalayan province, the richest bio-geographical province of the Himalayan zone and also falls in one of the biodiversity hotspots of the world. The Eastern Assam is at the junction of the Palaearctic, Indo-Chinese and Indo-Malayan Bio-geographic Regions. Biotic elements from all these regions occur in this area making it very rich in floral and faunal resources. In Jeypore RF, which is situated at an aerial distance of more than 20 km from the Makum coalfield, Kakati (2009) has recorded the presence of 26 species of mammals. Also in the same study five large carnivores (tiger, leopard, clouded leopard, wild dog and Malayan sun bear) and three species of elusive small cats (golden cat, marbled cat and leopard cat), were recorded. The Jeypore Reserve Forest now holds the distinction of being the only location in northeast India where the sympatric presence of all of these eight charismatic carnivores has been confirmed. As, Jeypore Reserve Forest is situated at an aerial distance of more than 20 km from the Makum Coalfield, may not be impacted by mining activities.

The study area includes Makum Coalfield area and its 10 km buffer zone that belongs to Digboi Forest Division, Assam. The area of the buffer zone is approximately 484.8 km^2 (Fig. 1.1). The back ground information along with description of study site is given in the subsequent chapter.

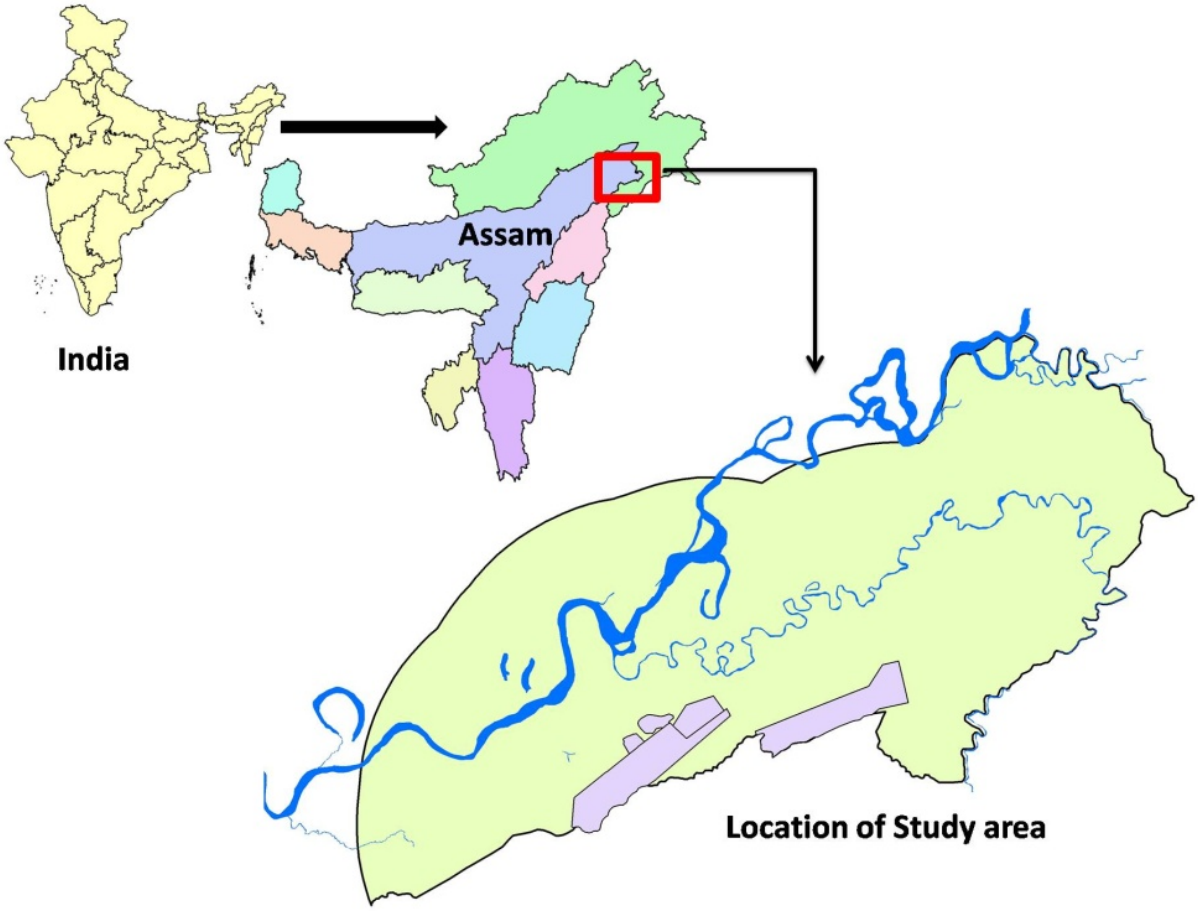


Fig. 1.1. Location map of Study Area

Chapter 2
Background Information

2.1 Reserve/Proposed Reserve Forest

The extent of the study area is roughly from 95° 36' 12'' E to 96° 01' 55'' E and 27° 12' 20'' N to 27° 26' 27'' N and the area is approximately 484.8km^2. Wholly or partly, 16 reserve/proposed reserve forests (RF/PRF) belonging to four ranges fall in this buffer zone (Fig. 2.1) namely:

- Lekhapani Range: Tipang RF, Tirap PRF, Dalai PRF, Paharpur RF, Saleki PRF, Tirap RF, Tipong PRF, Lekhapani RF.
- Jagun Range: Namphai RF, Kotha RF, Tinkopani RF, Namphuk RF
- Margherita East Range: Dirak RF, Upper Dihing RF (East), and Makumpani RF,
- Margherita West Range: Upper Dihing RF (West),

The current survey of wildlife was primarily confined to these 16 Reserves/proposed Reserve Forests.

2.2 Geology and Soil

The Study area is located in the Digboi Forest Division and in the foothills of Patkai range, consisting of upper tertiary rocks with tipam sand stone. The alluvial deposits of the Dihing River are characterized by their coarse nature, reddish colour and sandy clay. The soil is acidic in nature with considerable depth. The altitude ranges from about 140-715 m above mean sea level. The hilly terrain of the study site predominates with moderate to steep slopes. A number of streams pass through the study area.

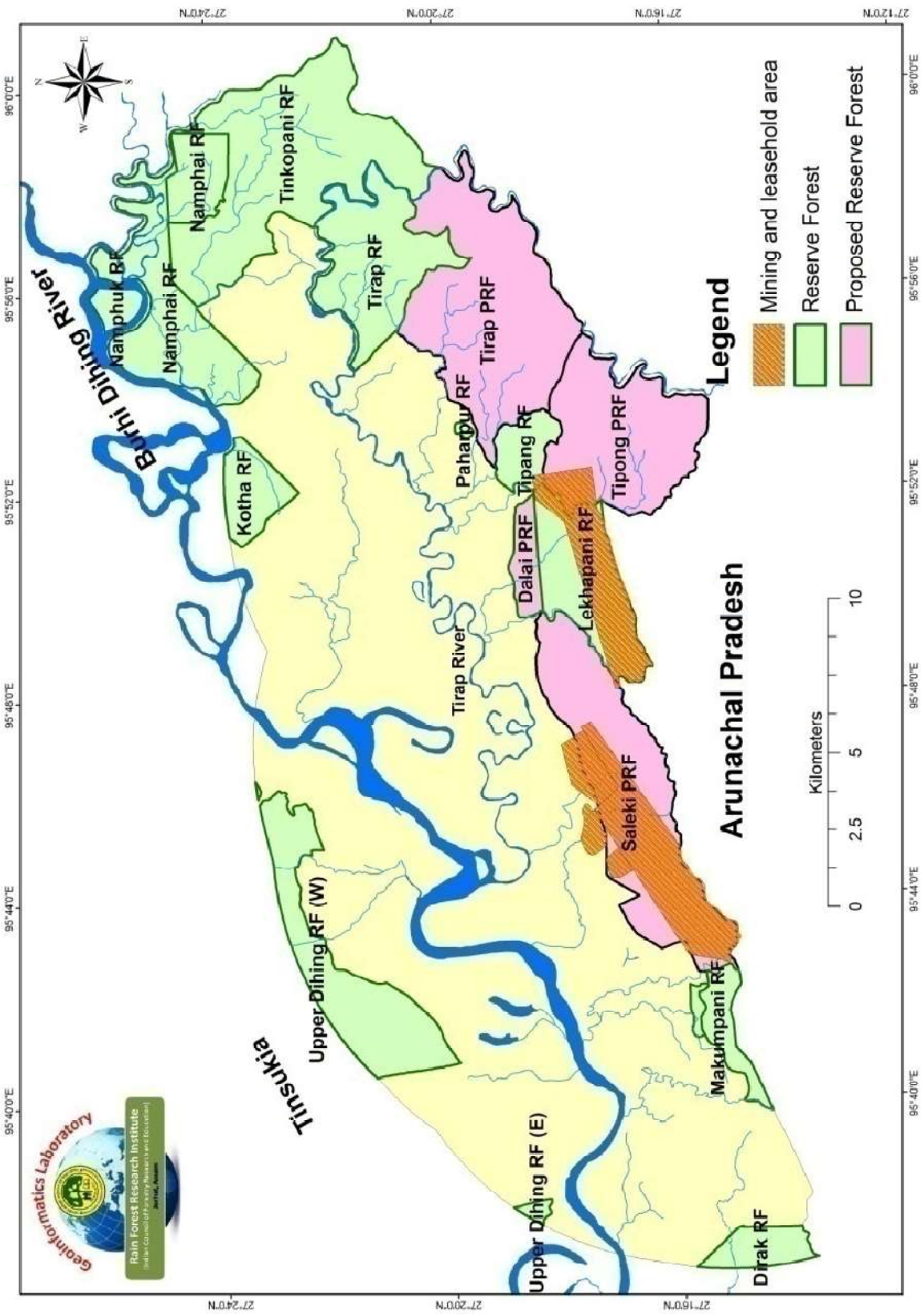


Fig. 1.1. RF/ PRF in the Study Area

2.3 Climate

The Study area falls under humid zone, characterized by high precipitation. High humidity and heavy rainfall are significant features of evergreen forests in this region. The period from November to February can be termed as dry season. June to September is the hottest period whereas December and January are the coldest. During the cold season mist in the early morning and evening is frequent. During December and January heavy dewfall is seen. The relative humidity is generally high during most part of the year, touching about 90 percent during monsoon.

2.4 Rainfall

Heavy downpour takes place during the monsoon months of May, June, July & August and flattens towards the end of the rainy season. The average rainfall recorded from 2010-11 to 2016-17 in this region shows that highest rainfall occurs during the month of July (428.86 mm) whereas the lowest average rainfall was recorded during November (17.11 mm) (Fig. 2.2). During the period from 2010-11 to 2016-17, the highest rainfall was recorded during 2010-11 and lowest during 2014-15 (Fig.2.3). The month wise rainfall data from 2010-11 to 2016-17 is given in Fig 2.4.

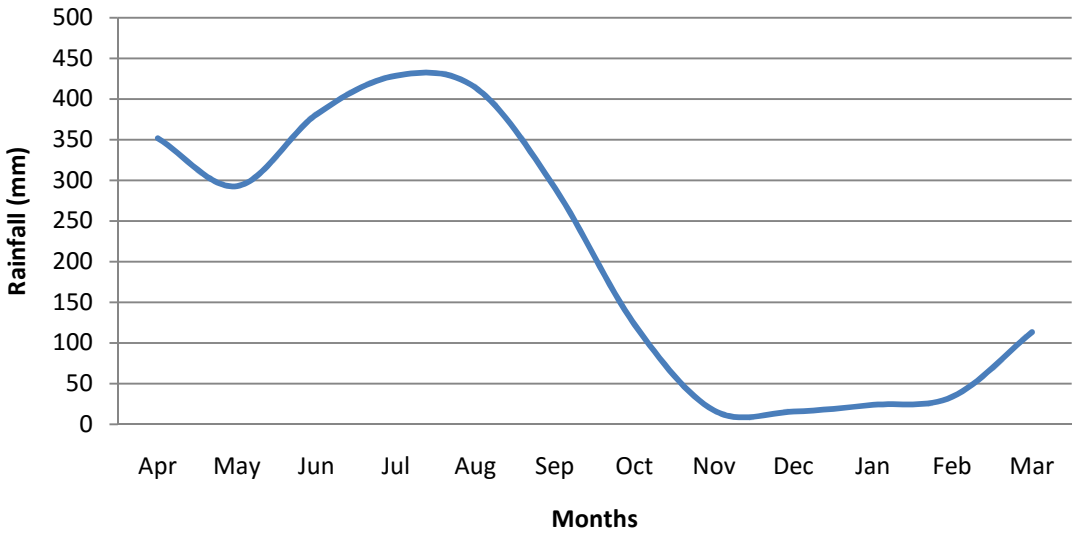


Fig. 2.2. Month wise average rainfall pattern in the Study Area

Fig. 2.3. Year wise rain fall pattern

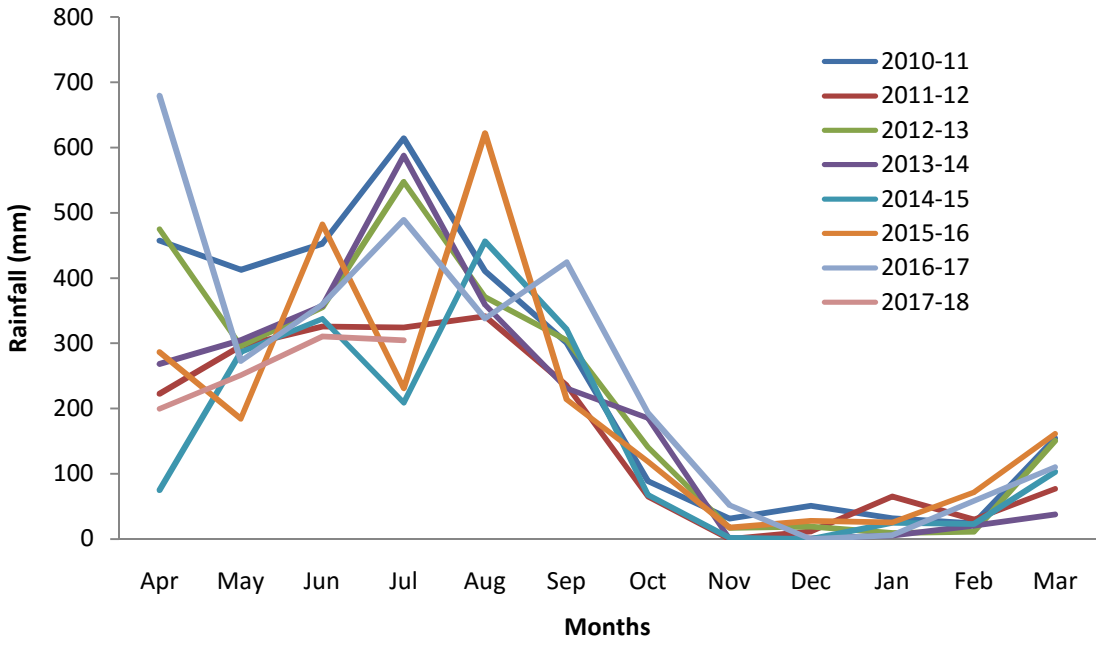


Fig. 2.4. Month wise rain fall in different years

2.5 Water Bodies

There are a number of water bodies in the study area. Two major rivers namely, Burhi Dhing and Tirap flow through the study area and their drainage systems support and regulate hydrological functions of the forest and habitat in the region.

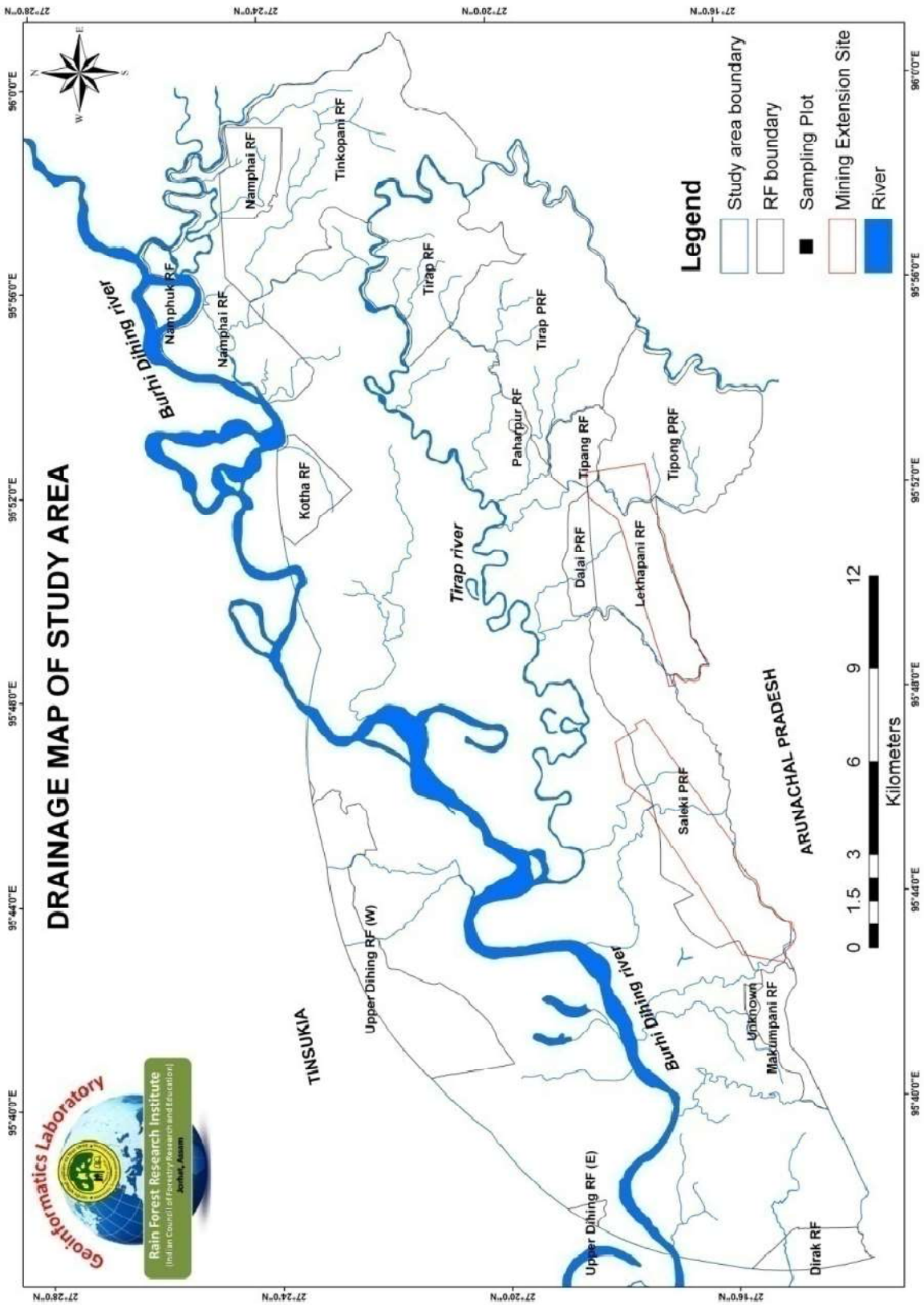


Fig. 2.5. Drainage Map in Study Area

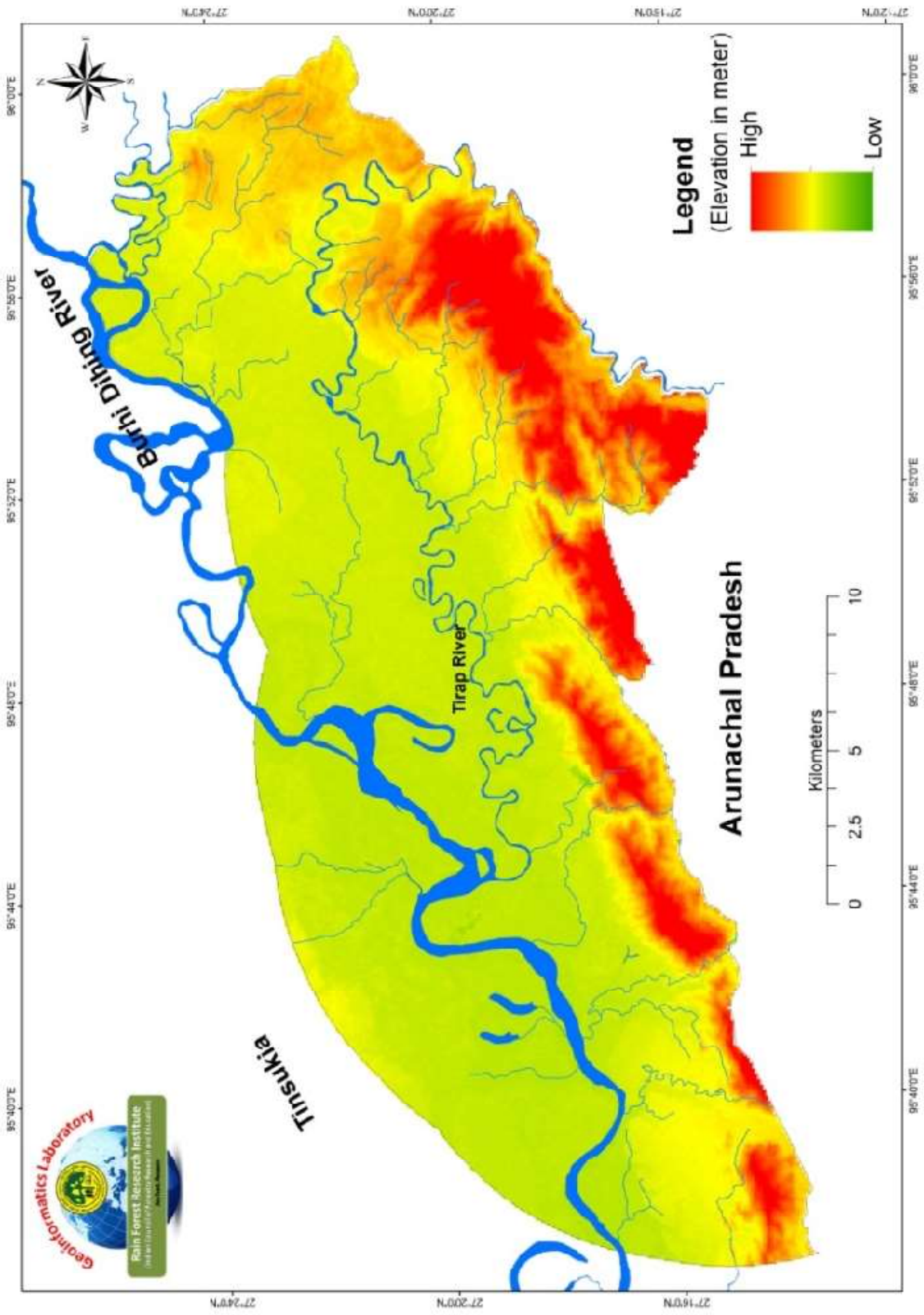


Fig.2.6. Digital Elevation Model of Study Area

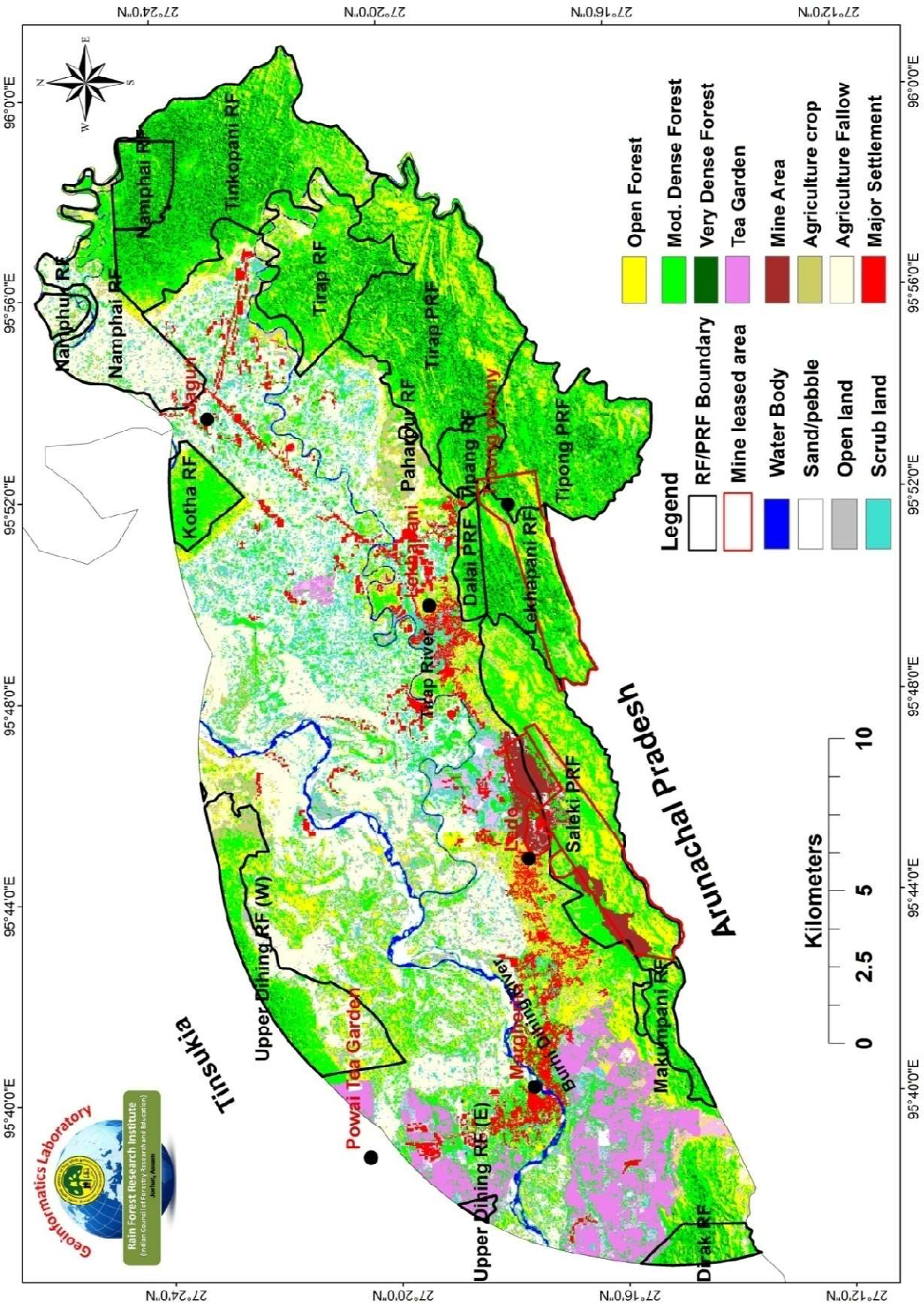


Fig.2.7. Land use/ cover map of the study area

2.6 Forest Types/Vegetation

The forest of the study area falls under IB/C1-Assam Valley Wet Evergreen Forest Type (Champion and Seth, 1968), or more commonly known as Upper Assam *Dipterocarpus–Mesua* formation. Being in a unique ecological location, this landscape is very rich in terms of flora and fauna. The peculiarity of this Assam Valley Lowland Tropical Forest is the three tier vegetation structure. The top tier looms over the rest and consists of isolated, tall, evergreen or deciduous trees which grow to a height of even up to 35-40 m. The common species are: *Dipterocarpus retusus* (Hollong), *Artocarpus chama* (Sam), *Shorea assamica* (Mekai), *Tetrameles nudiflora* (Bhelu) and *Teminalia myriocarpa* (Hollok). Each of these grows tall and handsome with spreading branches and abundant foliage. *Dipterocarpus retusus* occurs gregariously on the well-drained high level alluvial plains in the foothills while at higher elevations and on the ridges, it is replaced by *Shorea assamica* which occurs in more or less pure patches on comparatively dried & gravelly soils. Other species which are found to occur in the top canopy sporadically are *Michelia champaca* (Sopa), *Canarium resiniferum* (Dhuna), *Altingia excelsa* (Jutuli), *Amoora wallichii* (Amari) and *Ailanthus grandis* (Barpat). The middle tier consists of several medium sized trees growing up to a height of about 25 m. like *Mesua ferrea* (Nahor), *Cinnamomum glanduliferum* (Gonsoroi), Khokan (*Duabanga grandiflora*) etc.

Arenga pinnata, Caryota urens, Livistona jenkinsiana, etc. are few of the palms that occur in these forests. The epiphytic flora is very rich and some of the common epiphytic ferns are the species of *Aerides, Cymbidium, Eria, Pholidota*, *Dendrobium* etc. Along the hill slopes wild species of *Musa* comprising *Musa acuminata, M. balbisiana* and *M. rosacea* form thickets which are the prominent feature of the vegetation.

Trees are heavily plastered with lichens and festooned with climbers and epiphytes of the numerous lianas like *Pericampylus glaucus, Stephania elegans, Parabaena sagittata*, *Mimosa himalayana, Combretum acuminatum*, species of *Bauhinia, Derris, Entada, Gnetum, Hodgsonia, Piper, Raphidophora,* etc. The ground tier consists of shrubs, climbers, orchids and ferns. The ground flora is mainly represented by herbaceous elements such as *Phrynium* sp.*, Begonia roxburghii, Floscopa scandens, Rhynchoglossum* sp., *Abacopteris lakhimpurensis*, etc.

Because of the existence of quite close canopies in the overhead and resultant accumulation of thick humus on the forest floor, different species of herbs, ferns and grasses constitute rather a thick ground cover.

2.7 Wildlife

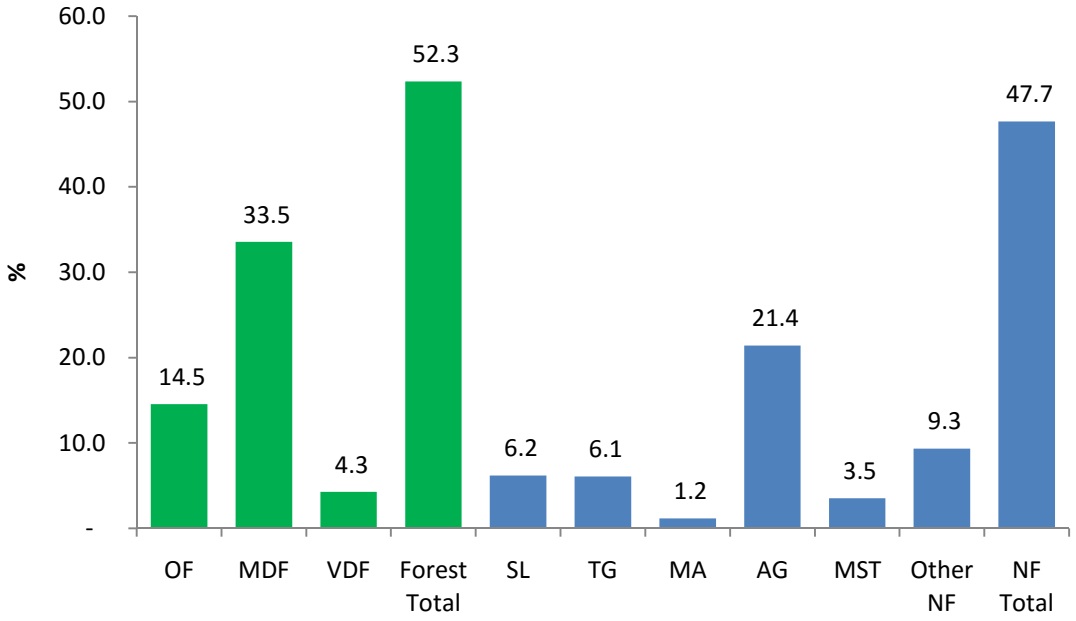
Bio-geographically, the study area falls under the North-East Brahmaputra Valley province 9 (A). The vegetation forms an ideal habitat for non-human primates. Till date, 46 species of mammals, 71 species of reptiles and amphibians, 70 species of fishes and nearly 40 species of dragonflies and 276 species of butterflies have been listed from this region. The recorded major mammal species from this landscape are – Hoolock Gibbon, Slow loris, Pig-tailed Macaque, Stump-tailed Macaque, Capped Langur, Asian Elephant, Tiger, Black Panther, Leopard, Gaur, Chinese Pangolin, Himalayan Black Bear, Himalayan Squirrel, Leopard Cat, Clouded Leopard, Porcupine, Crab Eating Mongoose, Sambar, Malayan Sun bear, Binturong, Barking deer, Golden cat, Marbled cat, Fishing Cat, Civet etc. (Anon. 2016)

The reptiles here include Burmese Rock python (*Python molurus*), Bamboo pit viper (*Trimeresurus gramineus*), King cobra (*Ophiophagus hannah*), Asian leaf turtle *(Cyclemys oldhamii),* and Water lizard/monitor (*Varanus salvator*). There are 13 globally threatened species here viz., the Slender-billed Vulture, White-winged Duck, Greater Adjutant, Greater Spotted Eagle, Lesser Adjutant, Beautiful Nuthatch, Marsh Babbler, Tawny-breasted Wren Babbler, White-cheeked Hill Partridge, Great Hornbill, Brown Hornbill, Oriental Darter and Painted Stork. At least 10 of the bird species are listed in Schedule-I of Wildlife (Protection) Act, 1972 including the state Bird of Assam-White-winged Wood Duck (Anon. 2016).

2.8 Land use/ cover

The study area includes Makum Coal field area and its 10 km buffer zone that falls under Digboi Forest Division. The area of the buffer zone is 484.8 km^2. The study area was categorized under major land use/ cover classes. 52.3% of the area is coming under forest cover. Moderately Dense Forests with an area of 16256.1 ha covers the maximum area followed by Open Forests (7043.8 ha) and Very dense forests (2070.4 ha). Among the other land uses, Agriculture with an

area of 10373.4 ha is the dominant land use followed by Scrub land (2994.1 ha), and Tea gardens (2940.5 ha) (Fig. 2.8).



[OF (Open Forest), MDF (Mod.dense Forest), VDF (Very Dense Forest), SL (Scrub land), TG (Tea Garden), MA (Mine Area), AGC (Agriculture crop), and MST (Major Settlement)].

Fig. 2.8. Area of each Land use/ cover

It was found that most of the areas (59.1%) of the study site are outside the reserve forest/ proposed reserve forest, whereas 40.9% are inside. The dominant land cover almost in every RF/PRF is Moderately dense Forest except Paharpur RF. Tinkopani RF and Tirap PRF found to have the highest cover of Very dense forests whereas, Saleki and Tirap PRF are found to possess highest open forest cover. Tea gardens are mostly found in Upper Dihing RF (E) and Dirak RF. Namphuk RF, Upper Dihing RF (E), Namphai RF, Paharpur RF, Upper Dihing RF (W) and Saleki PRF seem to be the most disturbed among all that comes with 10 km buffer area of Makum coalfields as the percentage of non-forest land use in those RFs/PRFs are 88.08 %, 86.09%, 75.05%, 68.15%, 37.61% and 16.99 %, respectively. The percentage area of Very dense forests also ranges from 0 to 1.3 %. The details are given in table 2.1.

Table 2.1: RF wise area under each Land use/cover

Land use/cover	OF	MDF	VDF	SL	TG	MA	AG	MST	Other NF	Grand Total
Tipang RF	24.1	282.6	77.5	0	0	0	0	0	0.5	384.8
Tirap PRF	714.3	1839.1	494	0	0	0	1.7	0	22.4	3071.5
Dalai PRF	41.7	205.8	30.2	0.3	0	0	0.7	3.6	14.5	296.8
Paharpur RF	6	1.2	0	0	0	0	13	0	2.3	22.5
Saleki PRF	968.8	1301.3	12.1	0	0	309.7	0	15.4	142.2	2749.6
Tirap RF	308.8	963	152	1.1	0	0	69	0	62.6	1556.5
Tipong PRF	353.5	1396.5	276.9	0	0	0	0	0	24.3	2051.2
Lekhapani RF	253.8	808.8	165.8	0	0	0	0	0	39.6	1267.9
Namphai RF 1	13.7	349.6	128.1	0	0	0		0	2.4	493.8
Namphai RF 2	89.1	296.9	5.9	93	0	0	930.6	9.1	146.2	1570.9
Kotha RF	94.2	389.6	1.9	2.3	0	0	7.7	0	10.2	506
Tinkopani RF	393.2	2162.1	552.1	0	0	0	14.6	0	57.1	3179.2
Namphuk RF	0	21.3	0	11.5	0	0	129.8	0	16.5	179.1
Dirak RF	66.3	238.7	45.6	0.6	17.6	0		0	13.4	382.2
Upper Dihing RF (E)	0	7.9	0	1.2	46.9	0		0	0.9	56.9
Makumpani RF	95.9	301.6	30.2	0	0	0		0	5.6	433.4
Upper Dihing RF (W)	330	668.9	20.5	40.4	0	0	395.2	0	179.1	1634
Inside PA/ PPA	3753.6	11235	1992.8	150.4	64.6	309.7	1562.3	28.1	739.9	19836.5
Outside PA/PPA	3290.2	5021.1	77.5	2843.7	2876	258.5	8811	1676.9	3790.5	28645.3
Total	**7043.8**	**16256.1**	**2070.4**	**2994.1**	**2940.5**	**568.2**	**10373.4**	**1705**	**4530.3**	**48481.8**
%	**14.5**	**33.5**	**4.3**	**6.2**	**6.1**	**1.2**	**21.4**	**3.5**	**9.3**	**100.0**

Chapter 3
State of Wildlife

The population status and habitat occupancy of target mammalian species (Elephant, Leopard and Hoolock Gibbon) and avifauna along with other prey species were estimated based on standard methodology (direct and indirect signs and camera trapping etc). For some faunal species, recent literature and report were also consulted. It is here to be mentioned that for a detailed complete study and precise estimation of population, at least 2 years time frame including all seasons is required.

However, study was carried out within the given timeframe and status of wildlife in and around Makum coalfield area was attempted to be estimated. Besides, the major species (Elephant, Leopard, Hoolock gibbon and avifauna), 27 major reptile species were found in the study area along with 6 amphibians. 144 butterflies species were also recorded (the full list is given in the Biodiversity management Plan). The habitat was mainly composed of floral species of 220 trees, 103 shrubs, 121 herbs, 37 orchids, 32 Pteridophytes, 65 bryophytes, 34 macro fungi and 23 lichens.

Elephant, Leopard, Hoolock gibbon and avifauna are the four targeted species for conservation in the present Regional wild life plan, the general status and distribution of which are given below.

3.1 Elephants

According to Choudhury (1999), there is a sizable population of elephant found in this landscape. This population extends from the base of the Mishmi Hills through Lohit Valley, Dapha Bum range, plains of upper Assam to the foot of the Naga-Patkai ranges. While a few gaps have already developed within the range, the elephants are still managing to move through tea plantations and cultivation. By district, this population covers Dibang Valley, Lohit, Changlang and Tirap in

Arunachal Pradesh, Tinsukia, Dibrugarh, Sibsagar, Jorhat and Golaghat in Assam and Mon, Tuensang, Mokokchung and Wokha in Nagaland.

As Reserve forest of Digboi division falls in Dihing-Patkai Elephant Reserve which constitutes an area of 937 km^2, all the sites are considerably used by elephants. In the study site, cases of human-elephant conflicts were reported. Being wide-ranging animals, elephants travel long distance in search of food and water and are threatened by many human activities. For elephants, large scale conversion of forests to monoculture plantations, croplands, and developed areas, has drastically reduced and fragmented the available habitats. This has resulted in compression of elephant herds in protected areas causing escalation of human-elephant conflict in the adjoining human-dominated landscapes.

The presence and distribution of Asian elephants in different protected areas of Digboi forest division covering Tipong and Tirap Reserve Forest, Saleki Proposed Reserve Forest and Lekhapani Reserve Forest was studied to determine the population structure of the Asian elephant.

3.1.1 Survey Methods

Block count method was used exclusively as direct count method, and line transect method for both direct and indirect methods of estimating population density in the study areas. Line transect sampling, based on the probability density function theory (Burnham et al., 1980), is considered practical, efficient and relatively inexpensive for many species. This method has been extensively used in different habitats for estimating densities of a variety of vertebrate taxa, and is a very ideal approach to count elephants directly or indirectly (Karanth and Sunquist, 1992; Varman and Sukumar, 1995; Varma, 2000). The study area was stratified based on different habitat types or elephant density. In each stratum, or elephant density zone, the number of transects of known distances was marked out, and vegetation modifications on transects was kept minimum to avoid attracting or repelling the animals. For elephants, a 3-4 km transect is considered to be an ideal length for sampling which were walked at a uniform pace. Density of groups (D) was calculated using the following equation:

$$D = nf(0)/2L$$

where, n is the number of animal sighted along the transect, L, the length of transect, and f (0) is the probability density function f(x) (Anderson *et al*., 1979).

The density of elephants was calculated using the program DISTANCE (5.0). To estimate the animal density, the density of groups will be multiplied by the mean group size. By following Goodman (1960) the standard error (SE) of the mean estimate can be arrived at, and 1.96 SE can be used to calculate 95% confidence interval.

$$\{SE(D)\}^2 = \left\{Y^2 \times \left(SE(Z)\right)^2\right\} + \left\{Z^2 \times \left(SE(Y)\right)^2\right\}$$

Where, SE = Standard error, Z = Density of groups/km^2, Y = Mean group size D = Density of individuals/km^2.

3.1.2 Survey Results

The study on density and distribution of Asian elephant was carried out between July-October, 2016 and a total of 15 transects of 3-4 km each were walked in various Reserve Forests and proposed Reserve Forests of Digboi forest division, namely, Tipong, Tirap, Lekhapani, Makumpani RF, Dalai Proposed RF and Saleki Proposed RF. Each transect was walked 2-3 times for collection of direct and indirect evidences of elephants. During the transect survey, dung and foot marks of elephants were recorded in Saleki Proposed Reserve Forest and Tirap Reserve Forest. GPS coordinates of all the indirect evidences were also recorded as shown in the map below. Calls from elephants herd were also recorded in Tirap Reserve Forest and Tinkopani Reserve Forest. During the study period, it was observed that most of the dung samples were found along road sides. It was also noticed that elephants were domesticated in the area and were used for pulling logs of large timber and for other purposes. As no direct encounter could be made during the study period confirmation on presence of wild Asian elephant could not be made as domesticated elephants are also present in the region. Indirect evidences collected can only confirm the presence of elephant but cannot distinguish between domesticated and wild elephant. Photos of domesticated elephant within the study area are presented. However, reports on presence of wild elephants were recorded from Tinkopani Reserve Forest both through indirect evidences and random questionnaire sampling with local people.

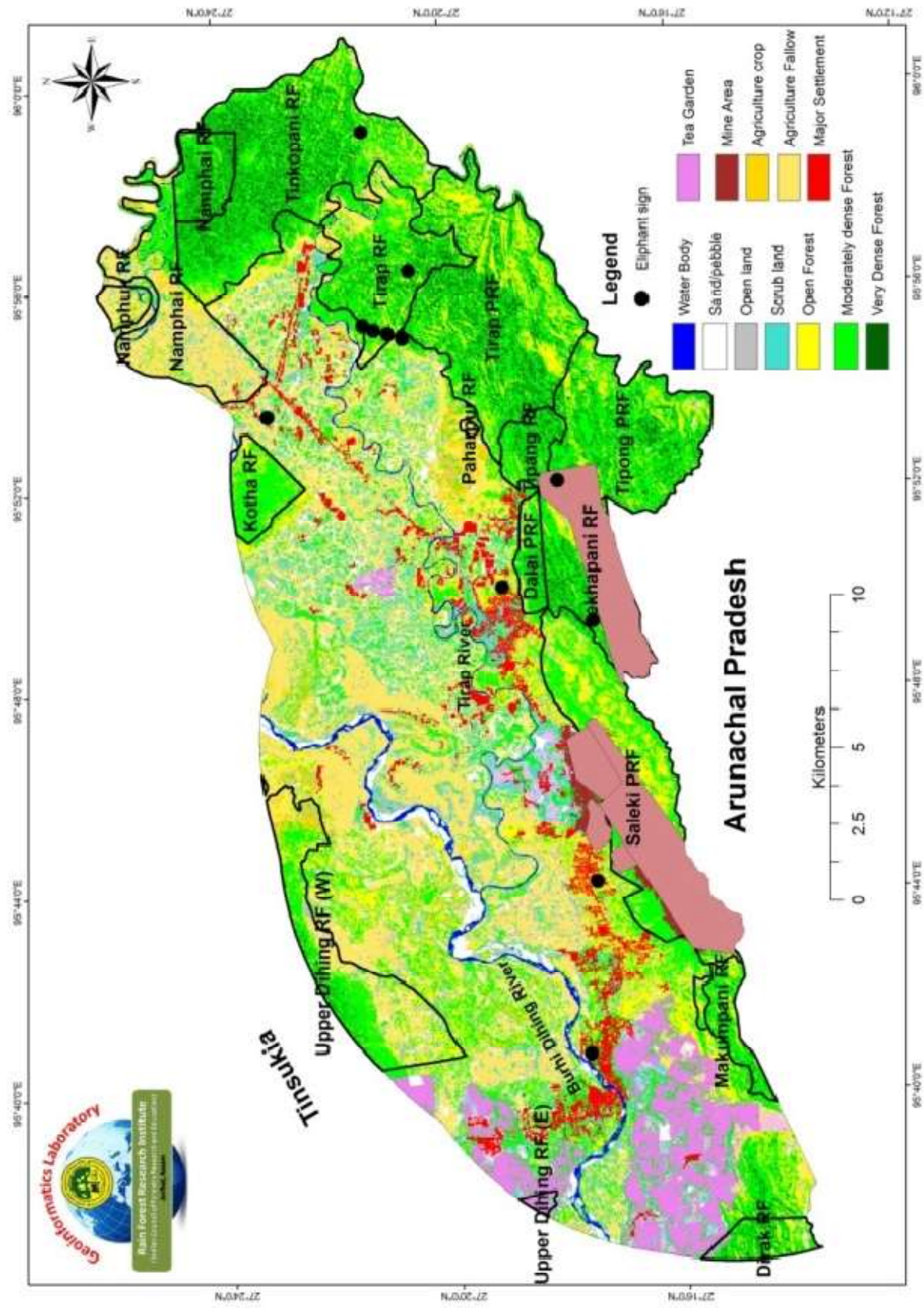


Fig. 3.1. Distribution of Asian Elephant in the study area

Direct and indirect evidences collected from fields and also information gathered from public consultation reveals that as the study area falls within Dihing Patkai Elephant Reserve, Elephants have been using some or the other part of Reserve forest as their migratory corridors. The map (fig.3.1) shows spatial distribution of Elephants signs encountered during the survey.

3.1.3 Present Status

During this short span of study time it was not possible to come up with any figure of elephant population in the study site. What best that could be done is gathering direct and indirect evidences of presence-absence of elephants which was done as shown in the above mentioned map. However, existing information base like Dihing Patkai Wildlife Sanctuary Management Plan (2011-2012 to 2015-2016) prepared by DFO, Digboi Division, Assam Forest Department was consulted and it was found that till now six enumerations were conducted for estimating elephant populations in Digboi Forest Division. The estimated population of Asian Elephant during 2011 was 204. The year wise estimation of elephants is given in the following graph (Fig. 3.2). The method adopted here for estimating the elephant population was total count followed by 15% sample check.

The pre-eminent threats to the Asian elephant today are habitat loss, degradation, and fragmentation, which are driven by expanding human population, and in turn leading to increasing conflicts between humans and elephants when elephants eat or trample crops. Elephants require much larger areas of natural habitat than most of the other terrestrial mammals and therefore, they are one of the first species to suffer the consequences of habitat fragmentation and destruction. Because of its gigantic size and large food requirement, the elephant cannot co-exist with people in areas where agriculture is the dominant form of land use. In extreme cases, elephants have been confined as so called ‘pocketed herds’ in small patches of forest in landscapes dominated by human beings. Poaching is a major threat to elephants although reliable estimates of the number of elephants killed and the quantities of ivory and other body parts collected and traded are scarce.

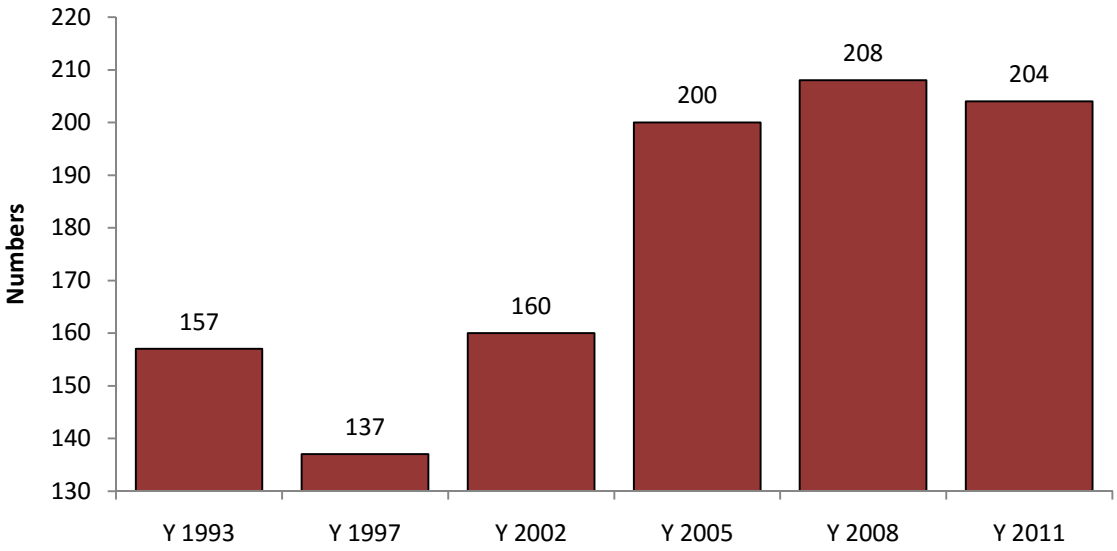


Fig. 3.2. Population of elephants

3.1.4 Status of elephant corridors in the region

As per the Wildlife Trust of India's report "Right to Passage-Elephant Corridors in India-2017", there are the following three elephant corridors in the entire Digboi Forest Division:

1. **Upper Dihing East-Upper Dihing West Block between Golai-Pawai:** This is situated at an aerial distance of about 13 km from the proposed Tikak Extension OCP. The corridor connects Upper Dehing Forest (East) to Upper Dehing Forest (West) including the areas of Golai Gaon No. 1, 2, 3, 4 & 5 villages and Borpowai Tea Estate. A major part of the corridor is devoid of natural vegetation and passes through tea gardens, human settlements, agricultural and degraded lands. This corridor has witnessed crop depredation by elephant resulting in discontinuation of cultivation by the adjacent villagers. In the recent past, new settlements have started coming in this 3 km long and 0.5 km wide corridor and human population in and around the corridor area has increased substantially. As a result, use of this corrodor by wild elrphants and other aniamals reportedly has reduced over the years. Margherita town is situated between this corridor and Makum coalfields. This corridor, apparently, will not be affected by the extension of Tikak OCP, the nearest proposed mine (Fig 3.3).

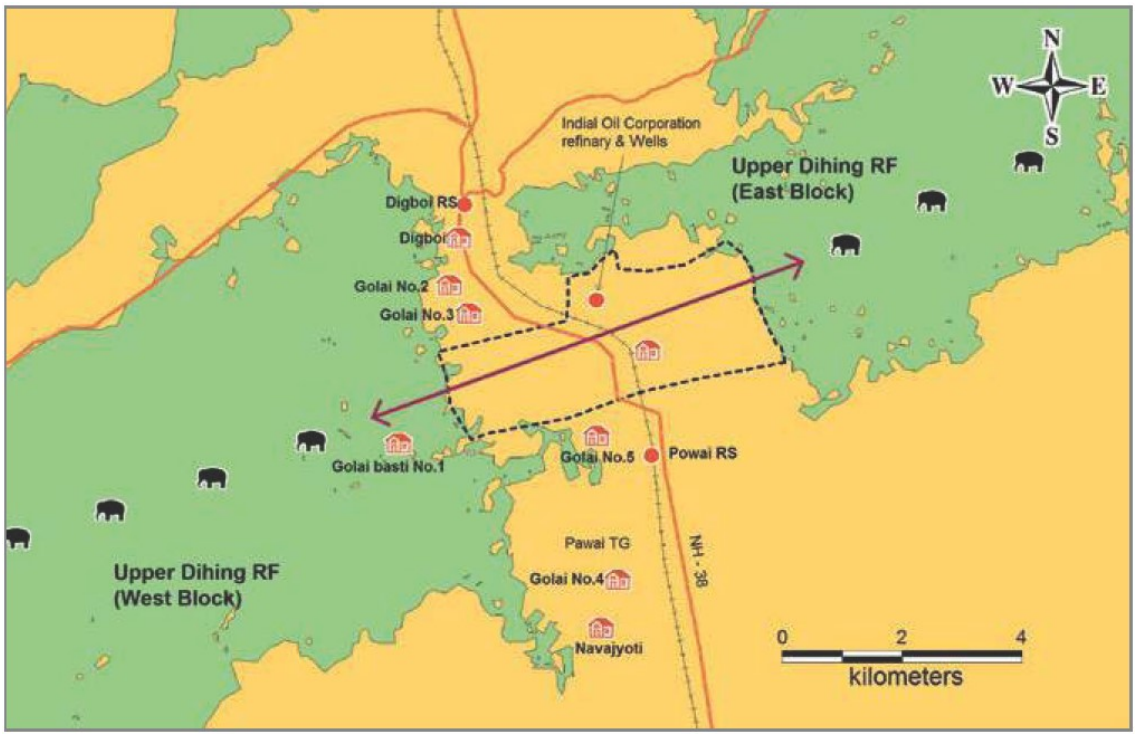


Fig 3.3: Map of Upper Dihing East - Upper Dihing West Block (source: WTI, 2017)

2. **Upper Dihing East-Upper Dihing West Block at Bogapani:** The corridor lies between the East and West blocks of Upper Dehing Reserve Forests and passes through Bogapani tea estate and a few settlement areas. This 2.5-3 km long and 0.5-1 km wide elephant corridor constitutes of Reserve Forest and some forest land which are leased to tea gardens and patta land. Bogapani, Panbari, Borbil-1 and 2 are the major settlements falling in this corridor. The aerial distance from the Makum coalfield is about 20 km and Digboi and Margherita towns are situated between this corridor and Makum coalfield. Frequency of usage of this corridor by elephants is regular (Seasonal; September to February). This corridor too, it seems, will not be affected by the extension of Tikak OCP (Fig 3.4).

3. **Kotha-Burhidihing Elephant Corridor:** This corridor connects the Kotha Reserve Forest and Burhidihing Reserve Forest of Doomdooma Forest Division, thereby maintaining a linkage with the Terai Reserve Forest, Kakojan Reserve Forest and Nalani Reserve Forest. Elephants cross the Burihiding River near the Kotha Kakharani settlement and pass through small tea gardens and agricultural land to enter Burihiding Reserve Forest. Length of the corridor is 3 km. and width is 1-1.5 km. This corridor is situated at about 12 km aerial

distance from the Makum coalfield lease areas. Direct impacts of mining activities in proposed Lekhapani OCP seems to be quite unlikely; however, as the vehicular movement will increase in the area after opening this mine, it may pose some disturbance for elephants in this area (Fig 3.5).

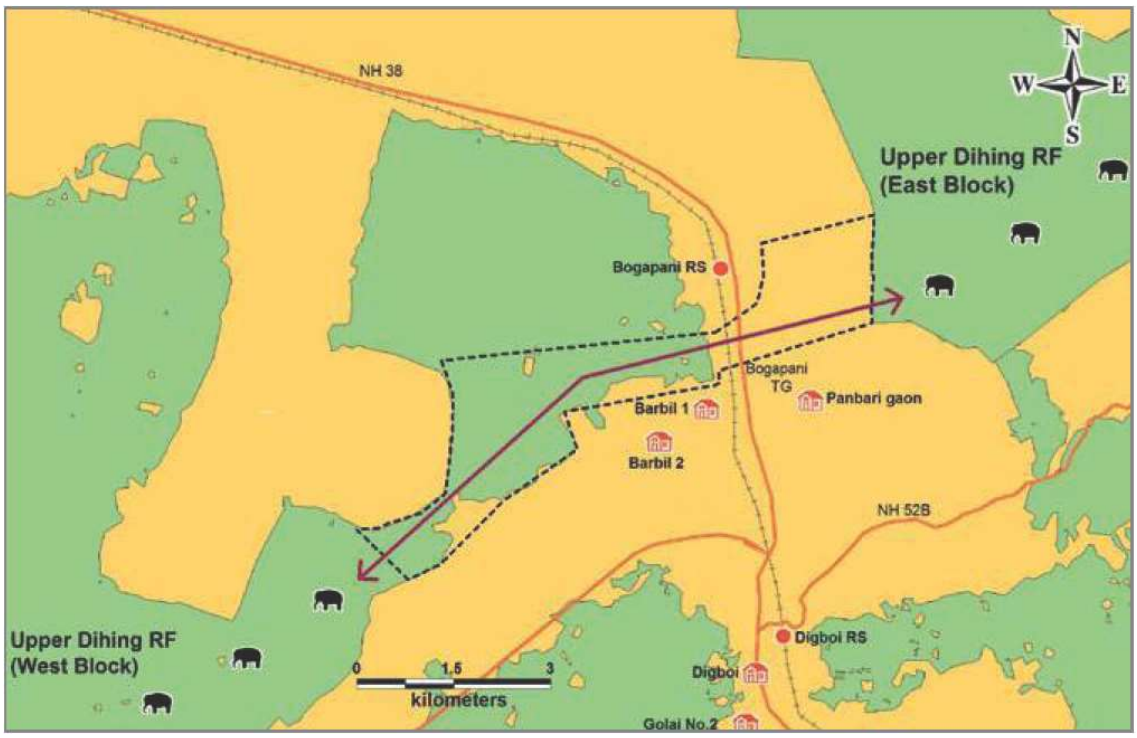


Fig 3.4: Map of the Upper Dihing (E)- Upper Dihing (W) Block at Bogapani (source: WTI, 2017)

Fig 3.5: Map of the the Kotha-Burihiding Corridor (source: WTI, 2017)

3.2 Hoolock Gibbon

3.2.1 Survey Methods

During the initial phase of the survey, different areas were selected for transects walk based on local interview and call of Hoolock gibbons.

- **Direct sightings:** Modified line transects method (Burnham et al., 1980) was followed for the survey, depending on the habitat and the forest condition. Transects were laid in a stratified random manner to cover all representative areas (Mueller-Dombois et al., 1974; Kent et al., 1994). The total length of transects was 28 km. Three observers walked randomly through existing forest trails and occasionally forest tracts without trails covering an average of 6–8 km/day. Transect walks were initiated in the morning (0600h) and terminated in the evening (1300h). The observers walked slowly along the transect pausing at regular intervals of 500m. On sighting the gibbon, the Global Positioning System location, the group structure and individual details, such as age, sex and number of individuals, were recorded. At 500m intervals, and at each location where the gibbon was encountered, the observers estimated tree height and canopy cover within an area of 10 m radius and also took note of the evidence and degree of grazing and logging in the study area.
- **Indirect evidence method:** Call-count method: This involved recording calls of hoolock gibbon; whenever calls were heard, in the absence of sightings, the distance of the call was estimated and recorded along with time, direction, duration and GPS co-ordinates of the observers.
- Secondary information relevant to the study, such as information about hunting and traditional beliefs, through informal interaction with forest field staff, local guides and elderly people were also recorded.

3.2.2 Survey Results

The study was carried out in Tipong Reserve Forest, Tirap Reserve Forest and Saleki Reserve Forest during July to October 2016. Surveys and transects walk were conducted to determine the occurrence, population status and distribution of Hoolock Gibbon in the reserve forests located in the vicinity of Makum coal mining areas. A total of 14 groups were recorded which were found to be distributed in different habitats from thick dense tropical forest to bamboo forest and fragmented forest land. The canopy cover in some of these areas was over 95%

comprising of bamboo forest, monkey jack (*Artocarpus lakoocha*), Chaplash (*Artocarpus chaplasha*), Indian drooping fig (*Ficus semicordata*), false hemp tree (*Tetrameles nudiflora*), Indian wild pear (*Pyrus pashia*) and false banyan (*Ficus actissima*). The degree of disturbance in areas of occurrence of Hoolock gibbons was found to be high. Disturbances included vehicular movement, human settlement, cutting and felling of trees, hunting etc. During the study period it was observed that Hoolock Gibbons were mainly confined to a few restricted forest patches. Therefore proper management plans are essential for the conservation of the species. The details of the survey are given below:

- **Tipong Reserve Forest:** The population surveys were mostly concentrated in and around Makum coal mining sites. Two troops comprising of six individuals of Hoolock Gibbons were found in the tropical evergreen forest of Tipong reserve forest. They were located in different tree associations and were observed at varying altitudes. The group composition, GPS position and time of observation are shown in Table 3.1. During the study period, Gibbons calls were recorded in nine different locations (Table 3.2).

Table 3.1: Sighting of Hoolock Gibbon in Tipong RF

SN	Location (GPS point)		Altitude (m)	Time	Adult male	Adult female	Infant/ unidentified	Total
	Latitude (N)	Longitude (E)						
1	27°17'24.36"	95°48'54.76"	256	08.00	1	1	2	4
2	27°17'37.09"	95°48'66.39"	376	09:30	1	1	-	2

Table 3.2: Gibbons call count in Tipong RF

SN	Location (GPS point)		Altitude (m)	Duration in minutes
	Latitude (N)	Longitude (E)		
1	27°17' 24.36"	95°48'54.76"	385	10 min
2	27°17' 24.36"	95°48'54.76"	385	8 min
3	27°17' 25.40"	95°48'56.23"	376	15 min
4	27°17' 25.40"	95°48'56.23"	376	5 min
5	27°17' 37.09"	95°48'66.39"	359	8 min
6	27°17' 40.12"	95°48'66.30"	357	8 min
7	27°17' 38.54"	95°48'71.39"	345	10 min
8	27°17' 38.54"	95°48'71.39"	345	10 min

Gibbon sightings were recorded mainly during the early hours from 0600 hours to 1000 hours and from 1600 hours till the sunset. Most of these sightings were just after sunrise between 0600 hours and 0800 hours. Generally, there were no gibbon sightings during the period from 1000 hours and 1400 hours.

- **Saleki Proposed Reserve Forest:** Hoolock gibbon population survey was mostly conducted in the buffer zone areas of the reserve forest. Some studies were also done in the core zone. Gibbons calls were recorded from two different locations in the tropical evergreen forest of the reserve forest. The occurrence of Assamese macaque was also recorded in the study area and perhaps is in sympatric relation with Gibbons. The habitats in Saleki Reserve Forest were found fragmented and adjoining with number of tea estates.

Table 3.3: Gibbon call count from Saleki PRF

S. No.	Location (GPS)		Altitude (m)	Duration in minutes
	Latitude (N)	Longitude (E)		
1	27° 17' 34.36"	95° 48' 54.76	279	12 min
2	27° 17' 41.47"	95° 48' 53.07	273	9 min

- **Tirap Reserve Forest:** A total of seven individuals were sighted in three groups in different locations in Tirap Reserve Forest. During the survey, a total of 21 km of transects were covered in different parts of the reserve forest and Hoolock Gibbons were found within an altitudinal range of 100–200 m. Of the three groups sighted directly, sighting time of one group was 0815 hours; another group was at 0940 hours and the third group was 0930 hours on different days. Gibbon calls of these groups were also recorded and average duration was 5 minutes; calls ranging from 1 to 5 minutes.

Table 3.4: Sighting of Hoolock Gibbon in Tirap RF

SN	Location (GPS point)		Altitude (m)	Adult male	Adult female	Infant/ unidentified	Total
	Latitude (N)	Longitude (E)					
1	27° 21' 28.21"	95° 54' 52.07"	194	1	1	-	2
2	27° 21' 57.90"	95° 58' 03.70"	171	1	1	1	3
3	27° 21' 41.27"	95" 21' 53.03"	245	1	1	-	2

- **Dalai Reserve Forest:** The area was mostly inaccessible due to dense vegetation and steep hilly terrain. In some forest patches, however, there were signs of high disturbance. Twenty two kilometers of transects were laid and walked to know the presence of Hoolock Gibbon in three different areas of Dalai Reserve Forest. In these forest areas, no evidence of presence of gibbons was found. Survey was conducted in the morning time from 0600 hours to 1300hours and then in the evening time from 1600 hours until the end of sunset. No gibbon sightings were recorded in this area. There were signs of heavy anthropogenic

pressure in the reserve forest near Makum coal mining sites of Lekhapani Reserve Forest. Local people reported the occurrence of Hoolock gibbons in Lekhapani Reserve Forest, but neither direct sightings of gibbons nor any indirect evidences or call sound were noticed.

3.2.3 Present Status

Based on the sighting record, two groups of two individuals each and third group of three individuals were located in Tirap Reserve Forest. In two groups adult male and female both were sighted, whereas in the third group, there were one adult male and female along with their infant.

Anthropogenic pressure was recorded in the reserve forests near Makum coal mining sites. Evidence of hunting and poaching were recorded in all six surveyed forest areas; there was no timber logging and agricultural activities. Hunting, illegal fishing and trapping of wild animals by local inhabitants, particularly the Naga tribe for bush meat and their body parts, was very common. Livestock grazing and human settlement were also recorded in and around these reserve forests. Encroachment in forest land for the commercial cultivation of tea, orange and ginger was quite evident in the areas, which is a serious threat to the gibbon population as it reduces total available quality habitat and fragmenting the forests. Loggings of timber and bamboo forest were also posing a serious threat for population of Hoolock gibbon in the study area.

Impacts of forest fragmentation on Hoolock Gibbon

Forest fragmentation will have numerous effects on Hoolock Gibbon. Small populations of gibbon dependent on irregular resources are highly vulnerable to changes in locality factor attributes or random fluctuations in the environment. They prefer sweet and juicy fruits, because of their simple digestive system. Apart from fruits they take leaves, young stems, flower buds, flowers, insects as well as climbers of upper canopy level for their food. Due to the seasonal availability of food, their movement in search of food in different seasons may vary up to several kilometers and are thus expected to be more seriously affected by habitat fragmentation. Any obstacle in their path like mining activity, habitations and roads/railways affects their movements, due to which the human-gibbon conflict arises.

3.3 Leopard

3.3.1 Survey Methods

- **Pugmark of leopard:** Leopards are predominantly solitary (except when mating or with offspring) and are capable climbers, leaving scratch marks on trees while climbing. Leopards walks in an alternating gait; zig-zag pattern when walking normally and leaves a rounded but asymmetric (especially hind foot) pugmark with a metacarpal pad or heel pad that has a trilobate posterior edge (three lobes or double indentation) and is often distinctly bilobate on the leading edge of metacarpal, particularly on the hind paw (Fig. 3.6).

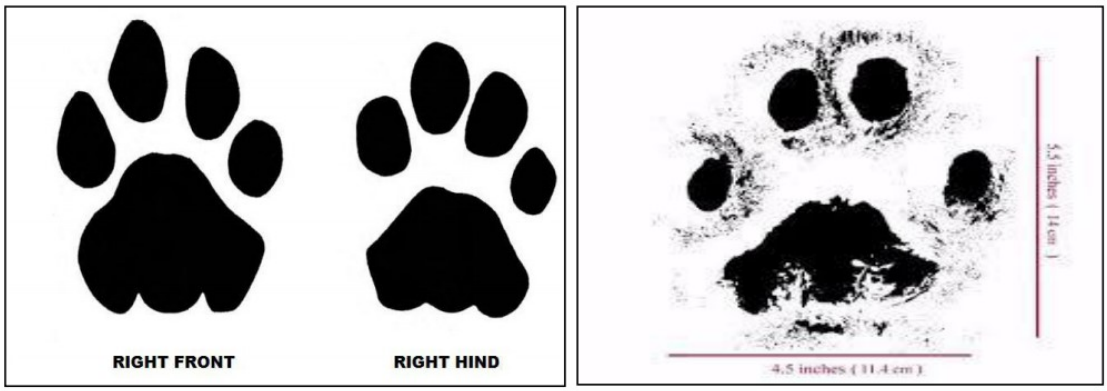


Fig. 3.6. Pugmark of leopard

The measurement of leopard pugmark is one of the most important tools used to study variations in individuals through measurement of Total length, Total width, and pad width of leopard pugmark. Identifying the species that deposited the faeces is a convincing indirect method as faeces are also long lived, especially in areas with little rain and minimal insect activity. Faeces may be solitary or in clumps typically, left on a shape pile or within a metre of a scrape but along or next to a trail. Scats of felid like leopard are often visible and easy to find large sample per unit effort. For estimation of population density of leopard in the study, line transects, trail walking method and camera trapping were used. The study area was divided into grids of 4x4 km and signs for presence of leopard were extensively searched. Leopard sign types were recorded using GPS (geo-coordinates) and additional field measurements to characterize the site and same were later added in GIS environment.

- **Camera trapping:** Camera-traps (self-activating cameras placed close to a bait or other attractant or on a frequently used path) were used to detect presence-

absence of species or to collect an index of abundance to record the presence of leopards. Camera trapping has been an excellent method for determining the population and status of felids in forest areas that are difficult to access. Carbone et al., (2001) demonstrated the method with theoretical foundations in capture-recapture sampling studies that estimated the densities of cryptic animals like tigers using cameras and analyzing the result using software programme CAPTURE. Specific sites for camera trapping such as walking trails, water bodies were selected and cameras were placed on trees at a height of 1-2m. The cameras were active for the whole study period with a 5 seconds gap between two consecutive photographs.

3.3.2 Survey Results

From July to October 2016, extensive surveys in Tipong, Tirap, Dalai, Dirak RF and Saleki PRF and were conducted and direct and indirect evidences were collected to assess the status and distribution of leopard. Local people were also interviewed to know occurrence of leopard in various fringe areas. In order to assess the awareness of local people on mammalian diversity in the study area and to verify it with camera trapping results, interviews and informal discussions were conducted with local people in 5 villages viz; Tipong colliery, Lekhapani, Lalpahar Sumi village, Hollong Pathar and Jagun Forest village, all residing in and around the reserve forests. The interviews were conducted in about 38 households which included *Gaonburas* (village heads), farmers, livestock herders, former hunters, wildlife guards and tracking guides. The respondents were shown photographs and drawings of the mammalian species and their knowledge on species occurrence and distribution were recorded. We focused on mainly leopards and conducted interviews and informal discussions about leopards. The respondents mentioned about killing of livestock by leopard in Dalai, Tipong and Tirap areas during August and September months.

Besides, camera traps were used in different strategic locations for photo-capture of leopards. A combined trapping effort of an average of 21 trap nights in different Reserve Forests (July–October, 2016) was done. During the transect survey, no direct evidence or presence of leopards and other felid species in the study area were observed. Extensive field work was also carried out in walking

trails and near water bodies to collect information on leopards; however no such evidence was found. Trees were also observed for claw marks of leopards but no signs were found. Camera traps were set for photo-capturing of wild animals, but except a few ungulates and civets, no photograph of leopards could be captured. Based on the survey work and camera trap results, it can be concluded that there might be a very small population of leopard and to know the exact population size more detailed study is required.

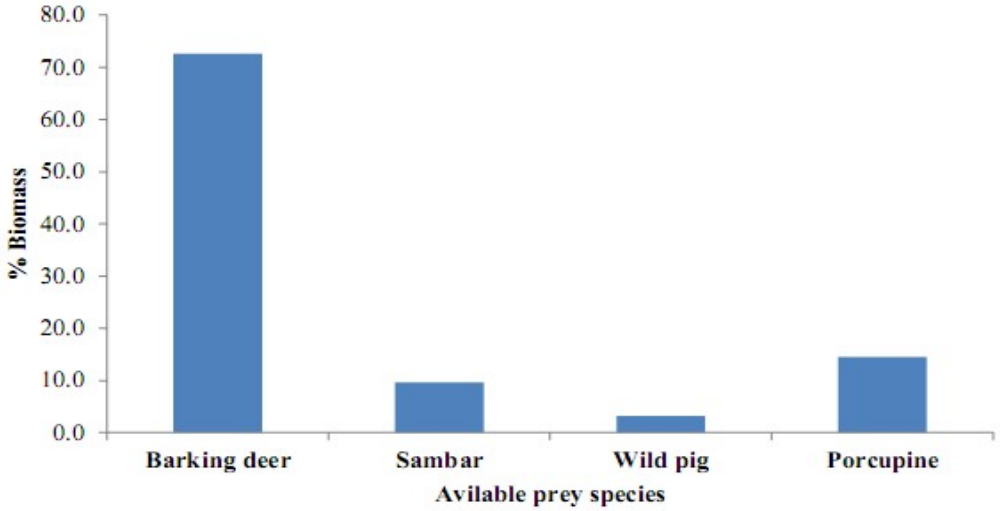


Fig. 3.7. Prey biomass available for leopards in intensive study area

3.3.3 Present Status

The relative significance of wild ungulates in the study area was calculated using a regression model that related prey biomass and leopard density to estimate the ecological carrying capacity of the forested area. A total of 15 transects were walked, with the lengths of approximately 2.0 km each. All transects were walked up to three times during the sampling period covering a total length of 90 km. A total of 203 indirect signs (hoof mark and pellets) were recorded for four different prey species (barking deer -169, sambar- 3, wild pig- 4, porcupine-27) in transect. Higher encounter rate of barking deer were reported as compared to other prey species which suggests that the small bodied barking deer are more resilient to hunting pressure. The estimated unit weight of the sambar was 120 kg, barking deer was 15 kg, wild pig 30 kg and porcupine was 18 kg in the study area. These unit weights are representing the actual population structure for each prey species in the study area. Based on prey sign encounter rate, the

available prey biomass was calculated as 37.2 kg/km. Based on Carbone and Gittleman's (2002) model, it was estimated that available prey biomass present in the forest areas, can support about 3-4 leopards in the study area. However, based on the reports published in the various local news papers on human-leopard conflict and the records of local forest division, the presence of more leopards in the study area covering both forest and non forest seems to be more likely and reasonable. Further, in such a fragmented landscape leopard is likely to develop avoidance behavior and therefore sighting becomes more difficult.

Leopard is an endangered species in India. It has wide distribution and its habitat is continuously encroached upon and degraded by the human beings. In Tipong, Tirap, Dalai, Lekhapani RF, and Saleki PRF forests are highly fragmented and interspersed with due to human interventions including shifting cultivation, mining activities (both legal and illegal), agriculture etc. Leopard seems to have developed avoidance behavior and consequently, the conservation efforts for the leopard are adversely affected.

3.4 Avifauna

3.4.1 Survey Methods

The bird population was recorded using the belt transect method (Cunningham et al., 2006). During transect walk, the observer recorded data on the sightings of bird species, number of individuals sighted and perpendicular distance from the line at which the species was sighted. Only those observations lying within 20m of either side of the transect line were recorded. The survey was conducted during the morning (between 07:00–09:00 hours) or evening time (between 16:00-18:00 hours) when there is maximum bird activity (Simons et al., 2006). According to Sutherland (2006), point count is the most efficient method of estimating avian density. This method entails the observers remaining at one point for a fixed time and recording the birds seen by the observers. Distances were recorded in terms of concentric zones around the point (50 m, 100 m) up to some limit beyond which the birds are not identifiable.

3.4.2 Survey Results

During the present study a total of 168 bird species belonging to 50 families and 106 genera were recorded. The maximum species were recorded from

Muscicapidae family (n=15), known as Old World flycatchers, followed by Columbidae, Scolopacidae, Picidae, Cuculidae, Covidae, Pycnonotidae, Accipitridae, Nectariniidae, Ardeidae, Alcedinidae, Campephagidae, Dicruridae, Motacillidae, Psittacidae, Strigidae, Cisticolidae, Estrildidae, Saturnidae and Turdidae families. Twenty seven families were represented by less than two species each as recorded during the study period. Species wise distribution of 168 species is given below in the graph (Annexure-I). These species are recorded mainly in Tipong, Tirap, Dalai, Lekhapani, Makumpani RF and Saleki PRF.

Muscicapidae family, known as Old World flycatchers, are forest birds and are mainly small arboreal insectivores. The second dominant family was Columbidae which represents Pigeons and doves. Other dominant family was Scolopacidae which represents- Snipes and sandpipers.

3.4.3 Present Status

In Tipong, Tirap, Lekhapani, Makumpani RF, Saleki and Dalai PRF, there are many conservation problems, which might be adversely affecting overall biodiversity including avian fauna. Habitat destruction and modification is the major and irreversible threat. Another most important threat is unsustainable exploitation of natural resources. This includes illegal felling, firewood collection, poaching etc. Disturbance to birds in the form of trapping and poaching are seen in most of the sites. Expansion of agricultural fields and degradation of natural vegetation along with slash-and-burn (jhuming) cultivation, excessive firewood collection are some other problem which is also of major concern.

Chapter 4

Wildlife Conservation issues and Strategies

Regional wild Life plan provides the appropriate frame work and road map for wildlife conservation of a given region. The objectives of the management are focused on the key species of the region, namely Asian Elephant, Hoolock Gibbon, Leopard and avifauna. The objectives include:

- To protect, conserve and improve the habitat attributes for Hoolock Gibbon, Leopard, Asian Elephant and other keystone species
- To restore and maintain habitat integrity for sustaining floral and faunal diversity.
- To create mass awareness and draw public attention and support for fulfillment of the above objectives.

The various problems and issues pertaining to wildlife conservation that was observed during field visit, literature survey, and in consultation with people are summarized below along with their strategies:

4.1 Habitat Management Issues

4.1.1 Fragmentation and Habitat Degradation

Makum coalfield area falls in biodiversity rich tropical evergreen and semi-evergreen forests of upper Assam, which is also form a part of Dehing-Patkai Elephant reserve. The soil quality of the study area is found quite good which is one of the reasons for the area to have historically supported substantially good forest cover. Even after condiderable amount of deforestation and forest degradation over the last couple of centuries, the study area (10 km buffer area of

Makum coal field) is having 52% forest cover, 33.5% of which comes under moderately dense forests followed by open forest (14.5%) and dense forests (4.3%). The ecosystem diversity of the area still seems to be good and serve as a natural refuge for a range of biodiversity. However, most part of the study area, forest fringe areas in particular, were found going under tremendous habitat degradation process resulting forest fragmentation. Namphuk RF is having 88.1% of its area coming under land uses other than forests followed by Upper Dihing RF (E) (86.1 %), Namphai RF (75.1 %), Paharpur RF (68.1 %), Upper Dihing RF (W) (37.6 %) and Saleki RF (17%). As far as open forest is concerned Saleki PRF and Paharpur RF with 35.2% and 26.5% area respectively are the most degraded areas (Fig. 4.1).

The main reason of forest fragmentation in the study area are authorized and unauthorized mining, extension of tea gardens, population growth, shifting cultivation, illegal felling, logging etc. Once a continuous landscape dominated by dense forest cover, the present study area was an important elephant habitat and also home of other 'resident' wildlife including Hoolock Gibbon, deer, Capped langur, Wild boar, Indian flying fox, etc. The reduction of effective habitat, alteration of micro climate and isolation of wild lives are some of the immediate outcome of forest fragmentation. Changes in the micro climate can lead to changes in the radiation fluxes disrupting the energy balances of the habitat, wind patterns and hydrological cycle. Tremendous habitat fragmentations coupled with other anthropogenic pressures, however, force the wildlife to frequently come out of their habitat resulting human-animal conflict in this region. The animals either adopts in a fragmented habitat or forced to migrate to the newer locations with predictable adverse implications or perish in case of new mining ventures like the proposed Lekhapani OCP.

- **Connecting Fragmented Areas**

The fundamental aim of conservation is to manage a wildlife habitat in an ecologically sensible way so as to allow free movements of animals. Traditional movement of large animals especially elephant get tremendously hampered by fragmentation. Small mammals, however, favours forested landscapes and do not

venture into open farmlands. Usually they use strips of wooded habitat to traverse agricultural landscapes (Merrian 1988).

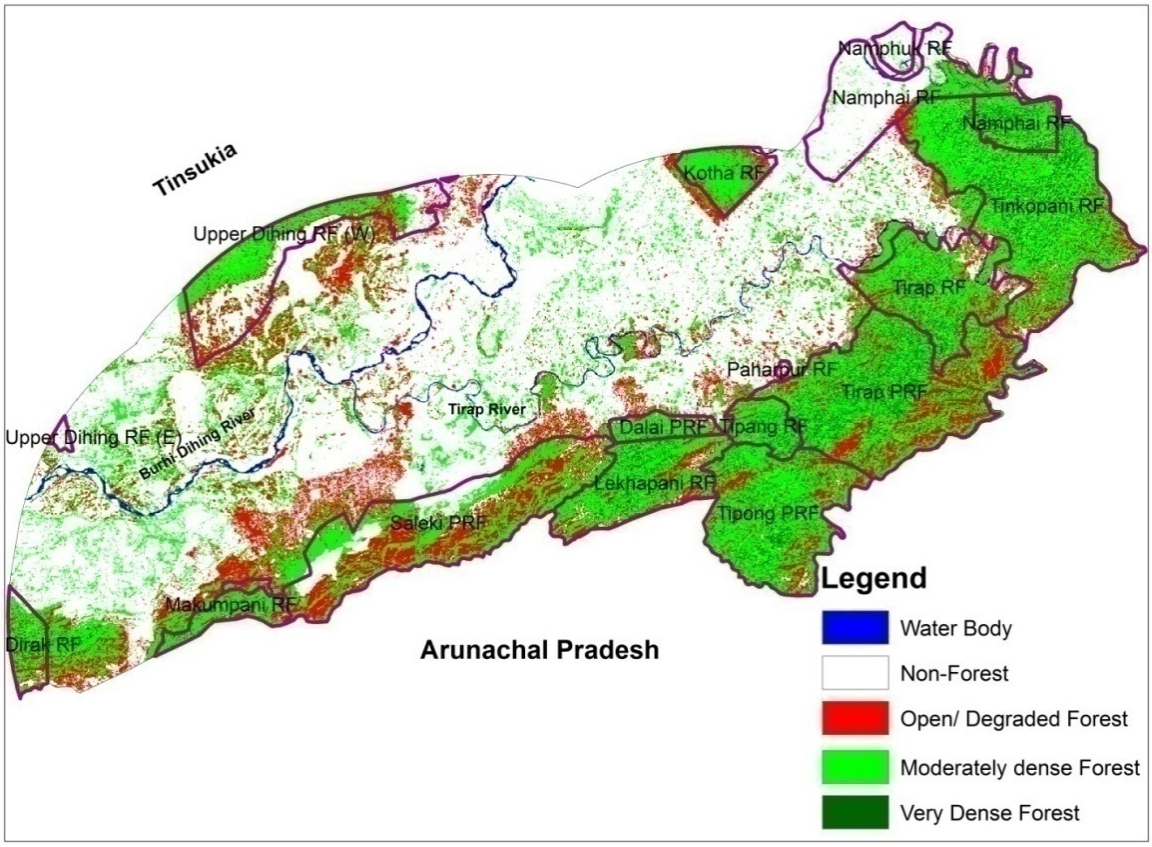


Fig. 4.1. Status of degradation of habitat in different RF/PRF

To ensure the unaffected dispersal and free home range movements of animal's, ecologists advocate **the idea of linking the fragmented areas of natural ecosystem with corridors or strips of protected land.** Fragmented ecosystems may be best protected corridors if they are surrounded by semi-natural ecosystems where a moderate amount of the natural biodiversity is maintained. Given the choice between having two natural ecosystems separated by a corridor through a highly disturbed forest land (Fig. 4.2) and two patches separated by a wide corridor of semi-natural ecosystems, the latter would help in better protecting the wild life movement under most circumstances (Hunter, 1997).

Considering the recent raise in the process of habitat fragmentation due to coal mining and allied activities the present home range of the elephants seems to be insufficient. However, to reduce the impact of mining it is proposed to undertake gap plantation with indigenous fodder species around the mine lease

area to protect the wild life habitat. It is also suggested that **waste should be dumped in such a way that the dumps should not create further obstaction for smooth movement of wildlife. It is recommended that the barrier created by dumping of 'over burden' should offer the opportunity of free movement by animals beyond visual contact of human beings, dumping should ensure the wild life movement passage to other parts of their home range.** Once the barrier is created, no activity should be allowed to take place within. Such simple solutions will ensure survival of the elephant movement and continued use by other wild animals and discourage fragmentation of important wildlife holding areas and blocking of migratory paths.

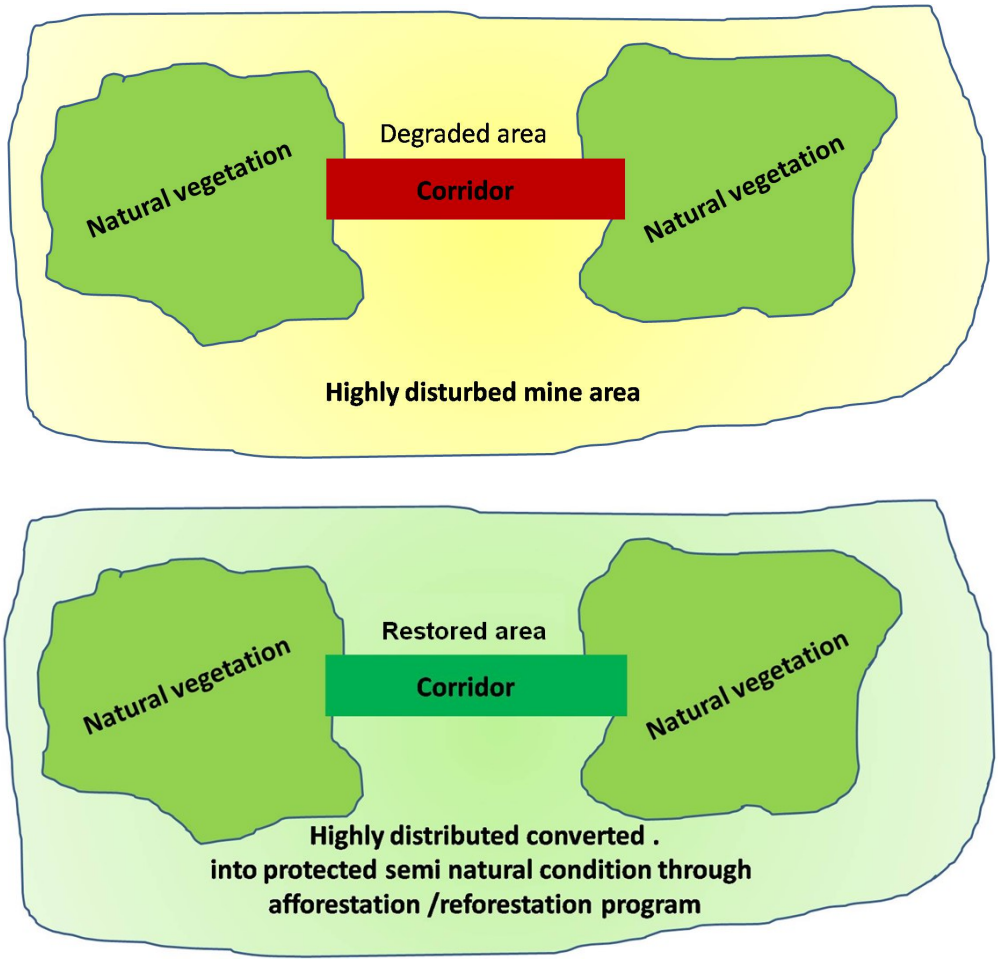


Fig.4.2. Two scenario of existing and proposed model showing development of corridor activity to restore the mined area through remediation

The restoration activities like afforestation/ reforestation programme in the fragmented areas by planting suitable native species especially food, fodder and shelter species (as suggested in the Biodiversity Management

Plan) may be started immediately and the protection of forest area by stopping or retarding illegal felling, grazing and conversion of natural forests for other purposes may be ensured. The broad framework for afforestation/reforestation programme is already given in the Biodiversity Management Plan, however, for further specification and identification of appropriate locations a rapid assessment for identifying the potential sites of the habitat that need to be forested in different parts of Digboi forest division may be conducted and the suitable plant species prevalent in the area may be planted. The planting materials may be prepared by the NEC in its own nursery or may be purchased from JFMCs, other reputed nurseries. The species which may be planted to improve the habitat are listed in Annexure-IX. Mass awareness programme among communities, regular patrolling, fragment monitoring programmes are some of the other remedial measures in this regard.

The natural regeneration of some of the native species was found hampered as evident from the less number of seedlings and saplings of species in many of the reserve forests especially nearby the coal mine and forests fringe areas. The dust from the coal mines and transports were also causing problems as it gets deposited on the nearby vegetation thereby retarding their growth, which may affect the reproduction.

Some of the important native species which should be used for afforestation/reforestation/plantation programme to improve the quality of habitats are given in Anexure-IX.

4.1.2 Illegal Felling and Firewood Collection

Illegal felling is primarily because of increased human population; forests are cleared to create more space for shifting as well as settled agriculture. The lowland forests are particularly affected by illegal felling which are evident in some of the protected areas too. No straight forward statistics is available as far as illegal felling is concerned; however in the present study area incidents of illegal felling seems to be very high.

Many of the study sites were found under severe pressure from the local people as they collect firewood from the adjacent forests on almost day to day basis. In many instances this collection goes beyond subsistence level which

hampers the cause of ecological conservation and result unremitting habitat degradation. The same was echoed by various participants in the stakeholder meeting. The SDO, Margherita informed that illegal felling is a serious issue in the region and offenders do the felling by using not only axes and even also by using the chain saws. It is suggested that **provisions for alternate energy sources for the local communities should be made and plantation of fuelwood species in homesteads and agriculture lands as well as the use of alternate energy sources should be promoted to reduce the illegal feeling and lopping of forests for fuel wood. To check the illegal felling watch and ward should be increased in the specific hotspot areas and felling camps should be established in specific areas.** Awareness programme to promote alternate energy sources and wildlife conservation should also be organized regularly. NEC may provide financial support to the forest department to deploy additional manpower from project affected people to increase watch and ward in the forest.

4.1.3 Shifting Cultivation

Shifting cultivation is the most common type of agricultural practiced in North East India, which has become a serious environmental issue. Shifting cultivation is prevailing in the southern part of the study area especially towards the Tipong colliery and proposed Lekhapani OCP. Shifting cultivation becomes unsustainable when practiced in a short cycle and results deforestation and degradation of forests. There are a few villages inhabited by Naga tribes who are traditionally practicing shifting cultivation over the years. Some time forest fire also occurs due to the burning of forest for preparation of new *jhum* land. **Mass awareness programme among the tribes regarding ill effect of shifting cultivation along with popularization of feasible alternative livelihood options should be encouraged which would ultimately ensure quality habitat for the wild life in this part of the area.** Shifting cultivation with long cycle (10-15 years) and Terrace cultivation may be encouraged in these localities for preventing degradation from short cycle jhum cultivation. Some other alternative means of livelihood options should also be encouraged.

4.1.4 Invasive Plants

The fringe areas of forests, even some parts of open and degraded forests

were found to be invaded by number of invasive species viz. *Mikania micrantha, Lantana camara, Chromolaena odorata, Eichhornia crassipes, Alternanthera philoxeroides, Bidens pilosa, Hedyotis auricularia, Hyptis suaveolens, Heliotropium strigosum, Mimosa pudica, Triumfetta rhomboidea, Urena lobata.* These alien species spread very fast and encroache the area of native species which results in a loss of native floral diversity. Invasive alien species also harms the regeneration process of important palatable species through competition for resources and through secretion of allelochemicals which results in scarcity of food and fodders in a forest area. Severe invasion of alien species was observed specifically in Selaki, Tirap, Namphai and Tinkopani forest area.

Consultation with local people also reveals that the number of invasives and their extent are increasing day by day which is a matter of concern for the overall health of the forests ecosystem as presence of invasive species actually indicates increasing disturbance in the system. It is recommended that these **invasive weeds should be eradicated and removed from the natural forests in a phased manner by mechanical or manual uprooting followed by immediate sowing of grasses. For uniform growth of grass and to prevent seeds being washed away, grass seed pellets can be sown. Pellets can be made by mixing powdered clay and farm yard manure in a 6:1 ratio and adding grass seeds into it. The mixture should be made into balls of 2 cm dia and Sun dried in summer to be sown soon after eradication of invasive species.** During the stakeholder meeting and baseline survey it was observed that local communities are not aware about the ecological impacts of invasive plant species. Communities should be sensitized about the ill effects of these invasives through a series of awareness programmes.

Eradication should be done by mechanical means and well before formation of seed so that the removed material can be used for mulching on OB dump areas. In addition, the non-woody material which cannot be used as mulch may be used in vermi-composting for use in the nursery. Possibilities of briquetting of woody material of the invasive species by mixing coal dust can be thought of as a source of revenue for the local people. In the eradication process of the invasive species care should be taken to replenish the native food plant sources of wildlife because

many of the invasive species have now become the food source for some wild animals.

4.1.5 Encroachment

Encroachment of forest area was observed in many places of study area. Most part of Paharpur reserved forest, for instance, is almost totally converted into tea gardens which are gradually extending towards the Tirap PRF.

Appropriate administrative and legal measures should be taken by Forest department so that further encroachment activities can be stopped. Alternate livelihood generation programme along with mass awareness programme should be taken for the improvement of the situation. The forest boundary should be clearly demarcated by sign boards, stone pillars, fencing etc. and periodic monitoring programmers through modern techniques like remote sensing, GIS and GPS based ground survey should be done. **A Wildlife Task Force (WTF) may be constituted by the Forest Department with close association of NEC and participation of the local people to combat such problems.**

4.1.6 Cattle Grazing

One of the main sources of income of villages of the study area is cattle rearing, many of the households have cattle and milk is sold in nearby towns. Due to the shortage of fodder in agriculture field or community lands, these cattle enter the forest area and graze over there which results in reduction of quality and quantity of both as well as vegetation cover and ultimately reduces the ability of the area to support herbivore wildlife.

Regular Training programmer on fodder cultivation with active collaboration with National level institutes like Indian IInstitute of Fodder Research (Jhansi), ICAR Regional Centers, agriculture universities, research organizations etc may be conducted to promote and enhance the production of fodder species in agriculture or community lands. The State Animal Husbandry Department may be roped in for monitoring the cattle diseases and vaccination of all the cattle to avoid spread to the wild. The villagers may be sensitized on this matter on regular basis.

4.1.7 Unauthorized Mining

During the field visit it was found that a number of unauthorized mining and subsequent smuggling of coal are going on in the study areas especially in the Tinkupani, Lekhapani and Seleki reserve forests, which need to be addressed. People clear the forest vegetation for making path and site clearing for these mining. These unauthorized mining inside the reserve forest, in dense and moderately dense forest patches results in further fragmentation which is of great ecological consequences. **Action should be taken to tackle this unauthorized mining through strengthening of the law and order machinery and creating awareness among the local people.**

4.1.8 Degradation of Water Sources

A number of streams and rivulets are originating from the hilly terrains of these reserve forests. In other words, these reserve forests falling within the study area function as catchments for all the streams, rivers or other water bodies. Some of the rivulets and rivers that pass through coal fields are: Namdang river (flowing besides Tikak OCP and Baragolai colliery, Ledo pani nallah flowing besides Ledo OCP, Lekhapani and Tikak river flowing besides proposed Lekhapani OCP and Tipong river flowing besides Tipong underground mines. The mining activities at Tikak, Ledo and Baragolai colliery have been reported to have affected a number of first and second order streams in the area feeding the Ledopani and Namdang rivers. **Protection of the rest of the streams especially the remaining Ledopani and Namdang rivers and Lekahpani River** in case of operation of proposed Lekhapani OCP is important for watershed protection and protection of natural aquatic systems available around the mines of NEC.

Creation of Water bodies: As mentioned above there are few water bodies created during the mining and backfilling exercises but these water bodies are insufficient to arrest the mine discharge and rain fall water. Therefore it is recommended that **more water bodies should be created** near to the natural water streams. **Sufficient number of salt licks should be placed around the water holes, which will supplement the nutritional requirements of the wild animals**. These measures have to be periodically evaluated and reported to the concerned authority for further improvement.

4.1.9 Soil Erosion and Related Issues

During the field visit it was observed that in most of the cases, the OB dump was not managed properly. The OB dumps were kept exposed for a long time which would result in heavy erosion during rainy season. The loose and sandy texture of coal OB dumps does not retain water for longer time and also becomes prone to soil erosion by rainwater which finally flows as runoff. The study area comes under heavy rain fall zone with average annual rainfall of above 2400 mm (as discussed in the previous chapters) and therefore the risk of severe soil erosion becomes even more. During the stakeholders meeting cum workshop and even during field survey the issue was reported by the project affected people around the mining sites. The effects of erosion are quite apparent in many of the nearby villages and it was observed that most of the low lying areas and streams are blocked by eroded OB dump soil. Erosion also results in release of acidic and toxic trace elements leached from coal and OB dumps which subsequently reaches streams and nearby agriculture fields. Soil erosion also results in tremendous increase of suspended and dissolved solid in the nearby water bodies which ultimately affect the aquatic flora and fauna by reducing opaqueness, changing the temperature regime and so and so forth.

Fig. 4.3 Uncovered OB dumps and resulting soil erosion

Mulching with shrubs, especially weeds and invasive plants removed from the nearby degraded habitat and forests may be done to minimize the impact of rain on loose soil and subsequent runoff and soil erosion. The added advantage of these mulching is that after decomposition, this material will mix up with soil and increase the organic matter content which again will make the soil porous, and act as a good soil binder, thereby reducing soil erosion. Moisture is the major component of the soil in relation to plant growth which not only provides water but also works as solvent for salts present in the soil, an essential component for

plant growth. Mulching conserves moisture, reduces the need for frequent watering, helps in better root growth, increases the infiltration of water, improves the water holding capacity of the soil and helps in increased microbial activity in the soil. The increased organic matter provides an ideal environment for growth of earthworms and other beneficial soil organisms. The mulching should particularly be done on the slopes which are subject to more soil erosion.

It is suggested that a detailed study for the soil erosion due to mining activities in the Makun Coalfield area should be conducted and mapping and prioritization of the soil erosion prone areas should be done. Site specific remedial measures like check dams, Rock fill dams, gully plugging, planting of native grass species etc should be implemented.

4.2 Wildlife Related Issues

4.2.1 Poaching

Poaching is a major problem for wildlife protection in North East Indian forests and the reason behind is manifold. Some of them are lack of awareness among the tribal population, complex topography, inaccessible areas, and cultural background. The present study area is inhabited by many tribes is not an exception either. As observed, most of the poaching is done for meat and other commercial purposes.

Poaching areas should be identified and a checklist of habitual offenders should be prepared. To check the poaching **watch and ward should be increased** in the specific hotspot areas and **anti poaching camps** should be established in specific areas for regular patrolling. **Mass awareness programme to promote wildlife conservation should be organized regularly.** NEC may provide financial support to the forest department for deployment of additional manpower. **Opening of outlet for low cost alternative animal protein like poultry and piggery** are some of the remedial measures in this regard.

4.2.2 Elephant Corridor

Elephants require large area for its survival and move across forests in search of food & fodder and also for breeding purpose. The core habitat of elephant was found divided into fragments in the present study area. The

fragmented patches of forests were surrounded by a matrix of non-forests land uses dominated by agriculture, human habitation, tea gardens etc. This has made migration/movement of elephant difficult in the study area.

Generally, wildlife corridors are created and managed to counter this problem of fragmentation in a landscape. As discussed in the previous chapter, Wildlife Trust of India (WTI, 2017) has identified 3 potential elephant corridre in the Digboi Forest Division and all of these elephant corridors fall beyond the 10km radius of Makum coal fields. Two corridors namely Upper Dihing East - Upper Dihing West Block Corridor at Golai-Powai and Upper Dihing East- Upper Dihing West Block corridor at Bogapani connect the east and west block of Upper Dehing Reserve Forest pass through the tea garden, paddy fields, roads, railway line and habitations. Kotha-Burhi Dehing corridor connects Kotha RF of Digboi Forest Division to Burhi Dehing RF of Doomdooma Forest Division. The direct impact of proposed and existing mining activities on these corridors seems to be limited. However, the corridors should be managed and restored in such a way that elephants do not stay there for long and only use the corridor as connecting routes to the adjoining forests. If there are obstacles in these corridors, elephant may choose another path for their movement and a situation of human animal conflict may arise. These corridors should be managed properly to avoid the chances of elephant straying into the coalfield areas from nearby forests.

4.2.3 Monitoring of Wildlife Population

The study area is situated adjacent to the Assam-Arunachal Border and the forest patches, in most of the areas, is part of a continuous landscape. The movement of wildlife, therefore takes place across the border. The estimation of population structure, abundance, distribution and monitoring of wildlife hence require joint approaches. Coordination among top officials along with ground staff is essential for effective estimation, monitoring and overall management of wild lives in this landscape. The forest in the study site is comes under two states Assam and Arunachal Pradesh, the estimation of population structure, abundance, distribution and monitoring of wildlife needed joint approaches of these state but the coordination between these states is very poor. Another main reason behind the lack of monitoring is insurgency of local militant groups inside the forest area.

Joint action teams comprising of members from Assam and Arunachal forest department and representatives of local fringe village communities may be constituted to monitor the wildlife population across the interstate border. The modern methodologies like remote sensing; Radio-transmitters, Camera traps, pugmark analysis, molecular marking etc. may be used for wildlife population monitoring. The training on census, management, use of modern instruments and monitoring techniques of wildlife must be provided to joint action teams and front line staffs of forest department by the National agencies like Wildlife Institute of India, Wildlife Trust of India, State wildlife cells, Universities etc.

4.2.4 Emergency Wildlife Management

Emergency Wildlife Management is an important component of any wildlife management plan. Makum coalfield is located within forest areas and since these forest areas are in continuation with other biodiversity rich areas, emergence of small and large wildlife in the coalfield area cannot be ruled out. Although the survey work revealed that there is no evidence of the presence of elephants continuously residing in the whole study area but the elephants may pass through these forests during their migration and the possibilities of elephant straying into the coalfield area from nearby forests of Digboi Forest Division cannot be ruled out. NEC Management should be having an emergency backup plan to face such crisis and any drifted wild animal whether it is **elephant, leopard or gibbon should effectively be rescued without harming the animal**. **This emergency backup plan should be prepared** in consultation with the Digboi Forest Division and the wildlife wing of local forest department. **An emergency crisis management team should also be constituted** by the NEC management and this team should able to perform the following task:

- Timely inform forest, veterinary and district administration in case wildlives stray out into adjacent villages or mining areas.
- It should prevent the killing of wildlife (especially Leopard and snakes) by villagers/labourers/staff untill the stranded wildlife is rescued.
- There should be a designated wildlife rescue vehicle team along with cages with this team for the capturing of wild animals straying into coalfield areas

or adjacent villages and subsequent release of these animals into other wildlife rich areas.

- Forest department may organize mock training drills to the proposed emergency crisis team to test their efficacy to deal with the wild animal straying situations.

4.2.5 Wildlife Health Monitoring

Vaccination of the grazing cattle is very much important to prevent any disease in cattle and subsequent transmission to the wild animals. Regular vaccination camps with the help of animal husbandry department should be organized in the forest fringe villages.

4.2.6 Rehabilitation of Rescued/Injured Animals

The rehabilitation of rescued and injured animals should be done with immediate effect. The rescue procedure involves capture of severely injured/sick animal, handling them for investigations, temporary shelter for recovery and release at the same site of capture or another suitable site. The detailed procedures for Rescue and Rehabilitation of animals is mentioned in the IUCN and MoEF & CC guidelines. These have to be strictly followed and monitored. The forest department and wildlife wing are to be equipped with proper veterinary facilities. It is proposed that atleast one well equipped mobile veterinary unit should be stationed at Lekhapani or Jagun range. **Training on rescue and rehabilitation and post-mortem procedures may be imparted to the staff of joint action team and selected villagers/EDC members**. The veterinarians may also be given refresher training to update their knowledge on wildlife health monitoring.

4.2.7 Lack of Information on Wildlife

An up-to-date database on biodiversity, phytosociology, population structure, abundance, distribution of individual species of study site is required for planning and management of the concerned area. However, information available for the present study area is limited to the Working Plans of various periods and EIA/EMP Reports prepared for various projects of the NEC and Assam Electricity department. Most of these reports are confined to a list of species with no

information on the status and distribution, which are prerequisites for developing management strategies. The problem was attempted to be addressed by preliminary survey of selected flora and fauna and a baseline data was prepared for Makum Coal field area. However, as it was mentioned earlier also, a detailed study of each species is required to know the exact population status and their distribution. The entire area should be covered to record the floral and faunal diversity along with information on the associates, abundance status and distribution using appropriate techniques. Thus, long term projects encompassing various seasons should be started. Short term studies may be followed to fill the gaps. The modern techniques of radio transmitters, camera traps etc may be utilized for population studies and monitoring purpose of fauna. Geographical Information System aided by GPS technology would definitely help in this regard. The database should be updated periodically and on a regular basis.

4.3 Infrastructure and Manpower Related issues

4.3.1 Lack of Trained Manpower

The area including Reserve and Proposed Reserve forests in and around Makum Coalfields is managed under 4 Ranges under Digboi Forest Divisions. There is a shortage of frontline protection staffs in Digboi Forest Division. The total sanctioned post of frontline protection staff includes 55 Foresters and 77 Forest Guards, but there are 23 posts of foresters and 47 posts of forest guards laying vacant. It is clear from the table that during the year 2005 only 27 posts were vacant but the number of vacancies has since increased to 80. It is also clear from the table that the 4 forest ranges which are managing the area in and around Makum coalfield are having the minimum number of frontline staff as these ranges are not in the priority list of the forest department for wildlife protection. Most of the available staff is engaged in the protection work in Dehing-Patkai wildlife sanctuary and elephant reserve. Shortage of the protection staff is one of the major hurdle in protection and conservation of the wildlife and biodiversity of forest area and enforcement of forest laws in the protected areas.

More man power will be required to implement the suggested biodiversity and wildlife management programmes successfully. In addition, it is important to have more man power in the form of forest watchers/trackers on contract/daily

wage basis to assist the staff in protection and management. **It is recommended to have provisions for requisite number of trained forest staffs for the implementation of biodiversity management plan and regional wildlife plan up to the end of the project period.** The investment on man power, increasing their capacity to face new challenges and equipping them with infrastructural facilities may be done by NEC.

4.3.2 Infrastructure for Protection Staff

There are 12 beat offices in all four forest ranges. These offices are not sufficient to monitor and protect the whole area. At least 2 more field patrolling stations are suggested to be established at each range to ensure the presence of uniformed frontline staff in almost all the areas. At least one field station should be in the form of watch tower in each range. The forest department may decide the locations and can also change the required numbers of these field stations.

4.3.3 Maintenance of beat offices/field stations

It is important that adequate facilities should be provided in the beat offices and proposed field stations to assure continuous stay of the staff in these stations. Keeping in view, proper maintinace of beat offices and field stations are proposed.

4.3.4 Maintenance of Office and Residential Buildings at Range Office

It is recommended to renovate/ maintain the existing office and residential buildings in the all 4 Ranges. Range offices should be furnished with standard furniture for seating and also for storage of files.

4.3.5 Quarters for Staff (duplex) and Maintenance

Residential facilities need to be improved and it is proposed to construct eight new duplex quarters (2 in each Range) to accommodate the staff with family. Construction of these quarters should be completed in first two years of the project. Locations of these can be decided by the respective range officers.

4.3.6 Provision of Four Wheeler and Motor Bikes

It was observed during the field study and was also informed by the officials of forest department that the infrastructural facilities in the field are not good enough. As per the information provided by the range officers, there is only

one four wheeler (Jeep/bolero) available in each range office which are not in good condition. Vehicle of Lekhapni range is being used for many other purposes also**. All the Range Officers have to be provided with four-wheeler vehicles and the foresters with motor bikes. Frontline staff should be provided with GPS and cell phones** to facilitate better communication in case of emergencies.

4.3.7 Capacity Building of Protection Staff

- **Insurance of frontline staff:** There are chances of injuries and deaths in the forest areas which performing duties and there is no separate insurance cover for the daily wage workers or protection staff. It is suggested to insure the staff against accidents and injuries on field.
- **Regular training of protection staff: Capacity of the frontline staff should be enhanced by the means of trainings of field techniques, biodiversity management, GPS handling and legal aspects of various Forest Acts.** Assistance from reputed organisations like Rain Forest Research Institute, Jorhat may be taken for that. The staff could also be motivated by providing them with field kits consisting of sleeping bag, ruck sack, compass, first aid kit, field shoe etc. There may be provision of rewards and incentives for good performance for different level of staff of forest department as well as the common public.

4.4 Socio-economic and Other Management Issues

4.4.1 Participation of Stakeholder in Planning

Wild life management plan should include people's participation and views of people should be given adequate weightage as they are the biggest and the most important stake holders. Accordingly, informal interviews were taken during survey of the present work and finally a formal stakeholders meeting cum workshop was organized at Margherita on 15 March 2017. It was expressed by the participants of workshop that there is a lack co-ordination and conviction between North Eastern Coal field, and major stake holders (Forest Department and the people of the region).

It is therefore suggested that before formulation of any plan or performing any activities related to conservation, dumping site selection, new construction,

developmental and CSR activities etc. there should be a meeting/workshop involving local communities and various other stakeholders including forest department, conservationists, elected representatives of gram panchayats and subject matter experts. The views and requirement of people should be given due importance. To reduce this interaction gap it is suggested that the **regular (at least annual) stakeholder consultation meetings should be organized** at Margherita sponsored by the NEC. These meetings will help in building confidence and thereby help in proper implementation of wildlife management plan in this region. The activities should be ecologically, socially and culturally viable to the communities and adequate participation of locals should be ensured in implementation of such plan/activities with guidance from the forest department or outside personnel/agencies.

4.4.2 Dependence of People on Forest

For any Biodiversity and Wildlife management plans it is necessary to know the dependence of the fringe villages on the forests. In absence of which, it is very difficult to involve people in the implementation of such plans. No information on dependence of fringe population on forest is available for the present study area. It is therefore suggested that there should be a detailed study on dependency of fringe villages on forest. The work has to be entrusted to some Institute of repute that deals with social issues and the report should have feasible strategies for reducing the dependence with alternative livelihood possibilities.

4.4.3 Human Wildlife Conflict

Data on the human wildlife conflict in the present study area is not available with Digboi Forest Division. However, the cumulative data for whole division including Dehing-Patkai Wildlife Sanctuary and Dehing Patkai Elephant Reserve shows that atleast eight persons were killed, six persons injured and many hectares of agriculture crops of nearby villages destroyed by the wild animals during the last five years. During the survey it was found that there is very less number of watch towers, patrolling staff, sound creating instruments, tranquilizer etc. to keep the wildlife away from human habitat.

During the stakeholder consultation meeting it was stated by some of the participants that there are much more cases of human wildlife conflict than actually reported. There are incidences, which have not been reported and claims have not been made due to the meager amount of compensation and its cumbersome procedure.

Table 4.1 Human-wildlife conflict cases (deaths and injuries) in Digboi forest division during the last 5 years

Sl. No.	Year	No. of Wildlife conflict case reported	Remarks
1.	2012-13	7	5 deaths and 2 injuries
2.	2013-14	3	1 death and 2 injuries
3.	2014-15	5	details not available
4.	2015-16	6	details not available
5.	2016-17	4	2 deaths and 2 injuries

The following measures are suggested for dealing with human-wildlife conflict:

- Forest department should collect each and every information from the villages on the occurrence of any human wildlife conflict like crop or property damage, attack on human by wild animals, visit of wild animal without damage also as well as the current methods of avoidance of wildlife and their effectiveness.
- A corpus fund should be created specifically for the timely payment to the human wildlife conflict affected persons.
- Priority areas for the human wildlife conflict should be identified. These mitigation measures should be socially accepted as well as ecologically sound and should not alter or prevent normal movement pattern of wildlife and specially should not hamper the elephant corridors.
- It is suggested to organize consultative awareness workshops to formulate site specific strategies and implement in each forest fringe gram panchayat. Respective gram panchayats should be made responsible for the regular maintenance of the structures made for the conflict mitigation.

4.4.4 Lack of Awareness among Local People and Field Staff

The awareness among locals and even frontline staff of forest department and NEC pertaining to various components of biodiversity in the region including RET, endemic flora & fauna, invasive and exotic plant species, keystone species etc

are lacking. During the stakeholder meeting it was further emphasised by some of the experts and participants and suggested to arrange awareness programme. Awareness campaign with the help of conservation organizations like NGO, educational and research institutes and Forest Department should be carried out and literature in the form of pamphlet, poster and calendar, etc. should be generated and freely distributed among the local folks. The local people should be included and the medium of communication should be in local languages. It is better if the trainer/ resource person is selected form the community itself which will ensure free interaction among the people. These awareness programmes can be organized in every six month and on the occasion of special days like World Environment Day, Forestry Day, Biodiversity Day etc. in each gram panchayat and townships. Various GIS based maps indicating the location of critical habitats, hydrological units, catchment area, exact mining site and OB dumps should also be generated with the help from reputed experts/organizations.

4.5 Eco-Development

The number of settlements and enclosures within the surrounding areas bring a lot of pressure on the wildlife habitat. A socio-economic survey of villages and settlements may be done to assess their dependence on forest resources and to understand their needs. The village communities may be encouraged to have their own cattle grazing blocks and cultivation of fodder species. Various programmes may be initiated and funded by NEC. Alternative energy source, such as solar light or chulhas may be supplied to the villagers to reduce pressure on adjacent forests. More employment may be generated for the people in the surrounding areas.

Addressing local social issues and ensuring people's participation in the management activities is important in case of a wild life management plan. Efforts to mitigate issues related to livelihood options of the people subsequently reduce their dependence on the forest. People’s participation and enhancement in their living standard by the process of eco-development also ensures support of the locals for conservation. Keeping in view of the benefits of eco-development, it is suggested to have the Eco-development Committees (EDC) in every gram panchayats in the study area. There are ten gram panchayats in the buffer zone of

the Makum coalfields, within 10 km radius, and they can be encouraged to form EDCs.

4.5.1 Formation of Eco-development Committees (EDCs)

One EDC at Gram Panchayat level is proposed to be formed in consultation with GP Chairmen and forest department. EDCs must include members from each hamlet and with proper representation of each community. The EDC members as well as other villagers should be briefed on the purpose of EDC formation and their respective role and responsibilities. The EDCs will work under direct supervision of the Forest Department.

4.5.2 Preparation of Micro Plans

Micro planning is a strategic empowering process that helps EDCs to learn more about themselves, their resources, issues and challenges, strength and weakness, and further to plan their own development and sustainable resource management. The EDCs are to prepare a micro-plan through a participatory process involving all the members, forest department, local NGOs and other stakeholders. The micro plan should be socially acceptable, have livelihood options, women empowerment and conforming to the existing rules and regulations. The dependence of the villagers on the natural resources, their socio-economic status and education level should be considered. Involvement of these EDCs in forest and wildlife protection, biodiversity conservation and mitigation of conflicts is also suggested.

4.5.3 Entry Point Activities

There is a tendency in villagers to expect immediate benefits from any of the programme and for the benefit to the community by addressing one of the most immediate demands of the people entry point activities are suggested. Start up funds or seed money for the initial support and for entry point activities can be provided by the NEC.

4.5.4 Capacity Building/Vocational Training for Villagers

It is important to make the villagers self sustainable through programmes under eco-development. Vocational training on various skilled based activities and entrepreneurship may be provided to the interested people. It is hoped that the

increased entrepreneurship, education and consequesntly employment oppurtunities coupled with extension programmes will lead to better awaereness of biodiversity and wildlife and reduced pressure on natural resources, thus augmenting the cause of conservation.

The identified areas for creation of natural resource related employment opportunities, market availability and possible source of technology in Assam are given in Table 4.3. At least one training programme every six months can be organized with about 20 participants.

Table 4.3 Suggested micro enterprises based on local forest resources

S. No	Name of the Profile	Market availability	Source of Technology
1.	Bamboo handicraft making	Bamboo handicrafts are in great demand in the state as well as throughout the country. It can be adopted as cottage industry for substantial income.	RFRI, Jorhat
2.	Lac cultivation	Lac cultivation can also be introduced in this part of Assam. Market linkage can be identified for the same.	RFRI, Jorhat
3.	Mushroom collection and cultivation	Mushroom cultivation is increasing in the north eastern state. Canned products have good market potential though out the country.	RFRI, Jorhat
4.	Sericulture	Muga silk is a common practice in the state of Assam. With a minimal training any of the interested local can start muga silk cultivation. It also has very good market potential in the state.	CMERTI, Jorhat
5.	Epiculture	Honey is has great demand in India and abroad. The rural entrepreneurs can start a honey bee rearing unit as it has good marketability.	SBEC Guwahati
6.	Livestock based entrepreneur-ship	Piggery, fishery, hatchery based entrepreneurship may be developed.	Animal husbandry and fishery department
7.	Eco-Tourism	Makum coalfield area is surrounded by well known ecotourism spots like Namdapha TR, Dehing-Patkai ER, Tea gardens, Joypur Rainforests, etc. Coal mine visit also has a good ecotourism potential.	Tourism department, Govt. of Assam

8.	Medicinal plant cultivation	This is an era of herbal medication. Medicinal plant cultivation is having huge market potential in every place of country	RFRI, Jorhat

Highlights of Species specific strategies

Elephant:

- Restoration of elephant population through conservation of the elephant's habitat and maintaining habitat connectivity by securing corridors.
- Management of human-elephant conflicts as part of an integrated land-use policy that recognizes elephants as economic and ecological assets from which local people should be benefited or at least should not be suffered.
- An integrated approach combining ecological, social and administrative means should be adopted to ensure protection of the species. Proper law enforcement, enhanced field patrolling, and regulating/curbing trade in ivory and other elephant products should be done.
- Monitoring of conservation interventions is also needed to assess the success or failure of the interventions so that midterm necessary adjustments can be made.
- Reliable estimation of population size and trends along with periodic updates should be done.

Hoolock Gibbon:

Wildlife in general and Hoolock Gibbons in particular get tremendously affected by forest fragmentation especially when the population size is comparatively smaller. Small populations of gibbon dependent on irregular resources are highly vulnerable to changes. As they are totally arboreal in nature, they prefer continuous patch with closed canopy. Gibbons prefer sweet and juicy fruits along with seasonally available young leaves, stems, flower buds, flowers, insects as well as climbers of upper canopy level as their food. Movement of gibbons therefore vary up to several kilometers as their food habits are seasonal in nature and as a result expected to be more seriously affected by habitat fragmentation.

- As habitat loss and destruction are the most important factors responsible for the decline of hoolock populations, a firm action is urgently needed for habitat protection and restoration.
- Tipong Reserve Forest, Tirap Reserve Forest and Saleki Reserve Forest areas are suitable habitats for the Hoolock Gibbon. These areas may be declared as wildlife sanctuaries, conservation reserves or community reserves for enhancing the protection status and for the development of eco-tourism with community involvement. These areas should be better protected, with increased staff, anti-poaching camps and regular patrolling. Measures should be taken to check encroachment in these forest areas and also control jhum cultivation as well as hunting.
- Education and awareness programmes should be conducted for local communities to promote conservation measures, and programmes should be set up for the regular monitoring of the gibbon populations in these areas.

- Detailed systematic research on re-assessment of Hoolock Gibbon status, ecology, population dynamics, assessment of habitat quality, habitat mapping using GIS, habitat fragmentation, gap analysis, genetic study, disease aspects, conservation threats to Hoolock Gibbon, education and awareness for different target groups in Gibbon habitat, especially in the protected areas, is essentially required.
- Well planned and long-term habitat restoration programmes should be initiated immediately for degraded Gibbon habitats.

Leopard:

- Improve Prey base through better protection by regular patrolling and monitoring.
- Develop a compensation mechanism against cattle depredation.
- Awareness Program for minimizing Human Leopard conflict.
- Enhancing local community support towards leopard conservation through orientation and capacity building initiatives.

Avifauna:

- Better protection from poaching
- Reduction of Use of pesticides in tea gardens through collaborative effort of various stakeholders.
- Awareness generation among local people and develop an eco-tourism perspective from Birding point of view.

4.6 Monitoring and evaluation

4.6.1 Constitution of Monitoring Committees at Forest Range Level

The activities proposed in the wildlife management plan will be carried out in the area under the overall guidance of the Assam Forest Department but for the proper implementation and monitoring of the various works done by the NEC for the management of wildlife and biodiversity in the Makum Coalfields area, a monitoring mechanism needs to be framed. A monitoring committee at block level in this case is suggested to be formed. The NEC shall constitute a committee at each Forest Range Level under the chairmanship of Divisional Forest Officer, Digboi Forest Division to monitor and review the progress of implementation of scheme/plan of wildlife and biodiversity management in and around the Makum Coalfields area.

The Monitoring Committee constituted as above shall *inter-alia* include as one of its members: -

1. Divisional forest Officer, Digboi Forest Division,
2. Range Officer of respective ranges;

3. President or his nominee of each gram panchayat falling in the respective Forest Range;
4. A subject matter expert from local colleges;
5. A representative of the local NGO working in the field of wildlife/biodiversity conservation
6. A scientist from reputed Research organisation like Rain Forest Research Institute, Jorhat, Assam (as expert consultant).
7. Representative of NEC.

Each committee will examine and monitor the progress of implementation of wildlife and biodiversity management plan on half yearly basis. Committee member will visit the site of interventions and check the work on site and will assess the success or failure of the interventions so that adjustments can be made as necessary. Expenditure occurring in each monitoring will be borne by the NEC Ltd. This committee will work for five years from the start of implementation of management plans.

4.6.2 Indicative Parameters for Monitoring Plan

The entire management and development plan is to be implemented, monitored and evaluated by involving local community on well defined Criteria and Indicators. Base line data shall be generated through experts in respect of:

- Population status of key wildlife species (Elephant, Gibbon, Leopard and avifauna): periodical survey
- Vegetation Status: biodiversity indices, habitat evaluation- periodical survey
- Status of Water resources- Quality and quantity- periodical survey
- Animal health and diseases- periodical survey
- Improvement level of income of Forest dependant local community
- Level of public awareness with respect to biodiversity conservation

Besides the above baseline data, information on the following shall also be collected:

- Cases of wildlife as well as forest offences in the area
- Regularity and effectiveness of community meetings in a year

- Quality Implementation of Annual Plan of Operation (APO)
- Periodic financial audit
- Periodic Social Audit of the Management Plan
- Regular Monitoring of status of health of animal species

4.6.3 Research and Further Studies

There are four proposed reserve forests in the study area. The status of these forests needs to be reviewed and for the better protection and conservation their status may be upgraded to reserve forest. By declaring these forests as reserve forest, encroachment of forest land, poaching and illegal felling and logging can be checked. Remaining biodiversity rich area may also be included in Dehing-Patkai elephant reserve.

Detailed systematic research on re-assessment of Hoolock Gibbon status, ecology, population dynamics, assessment of habitat quality, habitat mapping using GIS, habitat fragmentation, gap analysis, genetic study, disease aspects, conservation threats to Hoolock Gibbon, education and awareness for different target groups in Gibbon habitat, especially in the protected areas, is essentially required.

4.7 Budget for Wildlife Management Plan

A comprehensive time bound Biodiversity Management Plan focusing also on watershed protection and protection of natural aquatic systems available around the mines of NEC through a detailed impact study of surrounding area for extensive and intensive habitat management for targeted species (Elephants, Hoollock Gibbon, Leopard and Avifauna) and flora diversity has also been prepared simultaneously based on the data used in this plan. As wildlife management has been covered in Biodiversity Management Plan, therefore no additional budget is proposed specifically for the wildlife management plan.

References

Andersons, D.R., Laake, B., Crain, B and Burnham, K. 1979. Guidelines for transect sampling of biological population. J. Wildlife Management, 43 (1): 71-79.

Anon. 2016. Dehing-Patkai Wildlife Sanctuaries. http://assamforest.in/NP_Sanctuaries/ wls_dPatkai.php

Burnham, K.P., Anderson, D.R and Laake, J.D. 1980. Estimation of density from line transect sampling of biological populations, Wildlife Monograph, 72, 1-202.

Champion H.G., and S.K. Seth. 1968. A revised survey of the forest types of India. The Manager of Publications, Delhi-6.

Choudhury, A. 1996.Surveys of the White-winged Duck and the Bengal Florican in Tinsukia District and Adjacent Areas of Assam and Arunachal Pradesh. Guwahati: The Rhino Foundation.

Choudhury, A.U. 1997. The distribution and status of small carnivores (Mustelids, Viverrids, and Herpestids) in Assam, India. Small Carnivore Conservation, 16, 25-26.

Choudhury, A.U. 1999. Mustelids, Viverrids, and Herpestids of Northeastern India. Status Report 2. ENVIS BULLETIN. December 1999. pp. 43-47

Choudhury, A. 1999.Status and conservation of the Asian elephant (Elephas maximus) in north eastern India. Mammalian Review, 29, 141-171.

Carbone, C and Gittleman, J.L. 2002.A common rule for the scaling of carnivore density. Science, 295: 2273-2276.

Carbone, S., Christie, K., Conforti, T., Coulson, N., Franklin, J.R., Ginsberg, M., Griffiths, J., Holden, K., Kawanishi, M., Kinnaird, R., Laidlaw, A., Lynam, D.W., Macdonald, D., Martyr, C., McDougal, L., Nath, T., O'Brien, J., Seidensticker, D.J. L., Smith, M., Sunquist, R., Tilson, W.N and Shahruddin, W. (2001).The use of photographic rates to estimate densities of tigers and other cryptic mammals. Animal Conservation, 4, 75–79.

Cunningham, M.A., Johnson, D.H. and Svingen, D.N. 2006.Estimates of Breeding Bird Populations in the Sheyenne National Grassland, North Dakota. The Prairie Naturalist, 38(1), 50–67.

Goodman, L.A. 1960. On the exact variation of product. Journal of American Statistic Association, 708-713.

Kakati, K. 2004. Impact of forest fragmentation on the hoolock gibbon in Assam, India.Unpublished PhD dissertation. University of Cambridge, U.K.

Karanth, K.U and Sunquist, M.E. 1992.Population structure, density and biomass of large herbivores in the tropical forests of Nagarhole, India. J. Tropical Eco. 8, 21-35.

Kent, M and Coker, P.1994. Vegetation Description and Analysis: - A practical Approach. John Wiley and Sons, Ltd., Chichester, 363pp.

Mueller-Dombois, D and Ellenberg, H.1974.Aims and methods of vegetation ecology. John Wiley and Sons, New York, 547 p.

Sharmah, A.C. 2015.Working Plan for the Digboi forest divisions 2005-2006 to 2014-2015. Forest Department, Assam.

Simons, T.R., Shriner, S.A and Farnsworth, G.L. 2006.Comparison of breeding bird and vegetation communities in primary and secondary forests of Great Smoky Mountains National Park.Bio. Cons. 129, 302–311.

Sutherland, W. J. 2006. Ecological Census Techniques.Cambridge University Press, U.K.

Tiwari, S. K., Kyarong, S., Choudhury, A., Williams,. C., Ramkumar, K. and Deori, D. (2017). Elephant corridors of North-Eastern India. In: Right of Passage: Elephant Corridors of India [2nd Edition]. Menon, V, Tiwari, S K, Ramkumar, K, Kyarong, S, Ganguly, U and Sukumar, R (Eds.). Conservation Reference Series No. 3. WIldlife Trust of India, New Delhi.

Varma, S. 2000. Bird's diversity in the campus of Indian Institute of Science: An evaluation of two methods of estimation. J. Indian. Inst. Sci. 80, 511-518.

Varman, S.K and Sukumar, R. 1995. The line transect method for estimating densities of large mammals in a tropical deciduous forest: An evaluation of models and field experiments. J. Biosci. 20(2), 273-287.

Annexure I

Bird Species Recorded in the Study Site

S. No.	Family	Common name	Scientific name	Status	Relative Abundance
1	**Anatidae**	Lesser Whistling Teal	*Dendrocygna javanica*	R, C	0.0090
2	**Ardeidae**	Cattle Egret	*Bulbulcus ibis*	R, C	0.0492
3		Little Egret	*Egrettagarzetta*	R, C	0.0083
4		Cinnamon Bittern	*Ixobrychus cinnamomeus*	R, r	0.0007
5		Indian Pond Heron	*Ardeola grayii*	R, C	0.0273
6	**Anhingidae**	Oriental Darter	*Anhinga melanogaster*	NT,	0.0004
7	**Accipitridae**	Crested Serpent Eagle	*Spilornis cheela*	R, C	0.0018
8		Crested Goshawk	*Accipiter trivirgatus*	R, r	0.0007
9		Black Kite	*Milvus migrans*	R, r	0.0075
10		Pied Harrier	*Circus melanoleucos*	WM, r	0.0007
11		Shikra	*Accipiter badius*	R, C	0.0050
12	**Apodidae**	Asian Palm Swift	*Cypsiurus balasiensis*	R, C	0.0269
13		House Swift	*Apus affinis*	R, C	0.0122
14		Himalayan Swiftlet	*Collocalia fuciphaga*	R, r	0.0115
15	**Alcedinidae**	White-breasted Kingfisher	*Halycyon smyrensis*	R, C	0.0093
16		Common Kingfisher	*Alcedo atthis*	R, C	0.0122
17		Pied Kingfisher	*Ceryle rudis*	R, C	0.0018
18		Stork-billed Kingfisher	*Halcyon capansis*	R, r	0.0007
19	**Aegithinidae**	Common Lora	*Aegith inatiphia*	R, r	0.0011
20	**Aegithalidae**	Black-throated Bushtit	*Aegith alosconcinnus*	R, C	0.0025
21	**Bucerotidae**	Oriental Pied Hornbill	*Anthracoceros albrostris*	R, C	0.0029
22	**Corvidae**	Rufous Treepie	*Dendrocitta vagabunda*	R, r	0.0057
23		Grey Treepie	*Dendrocitta formosae*	R, r	0.0018
24		Collared Treepie	*Dendrocitta frontalis*	R, r	0.0007
25		Common Green Magpie	*Cissa chinensis*	R, r	0.0018
26		Jungle Crow	*Corvus macrorhynchus*	R, C	0.0111
27		Common Crow	*Corvus splendens*	R, C	0.0201
28		White-throated Fantail	*Rhipidura albicollis*	R, r	0.0043
29		Eurasian Jay	*Garrulus glandarius*	R, r	0.0007
30	**Chloropseidae**	Blue-winged Leafbird	*Chloropsis cochinchinensis*	R, C	0.0022
31		Golden-fronted Leafbird	*Chloropsis aurifrons*	R, C	0.0043
32	**Cisticolidae**	Grey-breasted Prinia	*Prinia hodgsonii*	R, C	0.0047
33		Striated Prinia	*Prinia criniger*	R, C	0.0083
34		Beavan'sPrinia	*Prinia rufescens*	R, C	0.0007
35	**Cettidae**	Black-faced Warbler	*Abroscopus schisticeps*	R, C	0.0014
36	**Campephagidae**	Rosy Minivet	*Pericrocotus roseus*	WM, r	0.0068
37		Scarlet Minivet	*Pericrocotus flammeus*	R, C	0.0083
38		Grey-chinned Minivet	*Pericrocotus solaris*	R, C	0.0018
39		Long-tailed Minivet	*Pericrocotus ethologus*	R, C	0.0022
40	**Coraciidae**	Indian Roller	*Coracias benghalensis*	R, C	0.0043
41	**Caprimulgidae**	Grey Nightjar	*Caprimulgus indicus*	R, r	0.0039
42	**Cuculidae**	Drongo Cuckoo	*Surniculus lugubris*	SM, r	0.0036
43		Common Hawk Cuckoo	*Heirococcyx varius*	R, r	0.0022
44		Indian Cuckoo	*Cuculus micropterus*	R, C	0.0075
45		Pied Crested Cuckoo	*Clamator jacobinus*	SM, r	0.0007
46		Red-winged Crested Cuckoo	*Clamator coromandus*	R, r	0.0011
47		Asian Koel	*Eudynamys scolopacea*	R, C	0.0047

48		Green-billed Malkoha	*Phaenicophaeus tristis*	R, C	0.0050
49		Lesser Coucal	*Centropus bengalesis*	R, C	0.0014
50		Greater Coucal	*Centropus sinensis*	R, C	0.0004
51	**Columbidae**	Pompadour Green Pigeon	*Treron pompadoura*	R, C	0.0025
52		Yellow-footed Green Pigeon	*Treron phoenicoptera*	R, C	0.0043
53		Thick-billed Green Pigeon	*Treron curvirostra*	R, r	0.0014
54		Pin-tailed Green Pigeon	*Treron apicauda*	R, C	0.0014
55		Green Imperial Pigeon	*Ducula aenea*	R, C	0.0068
56		Spotted Dove	*Streptopelia chinensis*	R, C	0.0111
57		Oriental Turtle Dove	*Streptopelia orientalis*	R, r	0.0086
58		Red Collared Dove	*Streptopelia tranquebarica*	R, r	0.0079
59		Emerald Dove	*Chalcophaps indica*	R, r	0.0111
60		Eurasian Collard Dove	*Streptopelia decaocto*	R, r	0.0047
61		Barred Cuckoo Dove	*Macropygia unchall*	R, r	0.0029
62	**Charadridae**	Little Stint	*Calidris minuta*	WM, C	0.0007
63		Red-wattled Lapwing	*Vanellus indicus*	R, C	0.0054
64	**Ciconnidae**	Openbill stork	*Anastomus oscitans*	R, C	0.0061
65	**Dicruridae**	Black Drongo	*Dicrurus macrocercus*	R, r	0.0122
66		Ashy Drongo	*Dicrurus leucophaeus*	WM, r	0.0083
67		Lesser Racket-tailed Drongo	*Dicrurus remifer*	R, r	0.0101
68		Greater Racket-tailed Drongo	*Dicrurus paradiseus*	R, r	0.0029
69	**Dicacidae**	Fire-breasted Flower pecker	*Dicaeum ignipectus*	R, C	0.0025
70		Scarlet-backed Flower pecker	*Dicaeum cruentatum*	R, C	0.0022
71	**Estrildidae**	Scaly-breasted Munia	*Lonchura punctulata*	R, C	0.0043
72		White-rumpedMunia	*Lonchura striata*	R, C	0.0050
73		Black-headed Munia	*Lonchura malacca*	R, C	0.0065
74	**Laridae**	River Tern	*Sterna aurantia*	R, C	0.0047
75	**Lanidae**	Brown Shrike	*Laniuscristatus*	WM, r	0.0057
76		Grey-backed Shrike	*Laniustephronotus*	R, r	0.0065
77	**Muscicapidae**	Little Pied-flycatcher	*Ficedula westermanni*	R, r	0.0018
78		White Gorgeted-flycatcher	*Ficedula monileger*	R, r	0.0025
79		Sapphire Flycatcher	*Ficedula sapphira*	R, r	0.0011
80		Rufous Gorgeted-flycatcher	*Ficedula strophiata*	R, r	0.0014
81		Snowy Browed-flycatcher	*Ficedula hyperythra*	R, r	0.0018
82		Pygmy Blue-flycatcher	*Muscicapella hodgsoni*	R, r	0.0011
83		Magpie Robin	*Copsychus saularis*	R, C	0.0104
84		Common Stonechat	*Saxicola torquata*	WM, r	0.0029
85		Grey Bushchat	*Saxicola ferrea*	R, C	0.0032
86		White-rumpedShama	*Copsychus malabaricus*	R, r	0.0022
87		White-crowned Forktail	*Enicurus leschenaulti*	R, C	0.0032
88		Black-backed Forktail	*Enicurus immaculatus*	R, C	0.0039
89		White-capped Water-redstart	*Chaimarrornis leucocephalus*	R, r	0.0050
90		Daurian Redstart	*Phoenicurus auroreus*	WM, r	0.0014
91		Plumbeous Water-redstart	*Rhyacornis fuliginosus*	R, C	0.0036

92	**Motacillidae**	White Wagtail	*Motacilla alba*	WM, C	0.0097
93		Grey Wagtail	*Motacilla cinerea*	WM, r	0.0079
94		Citrine Wagtail	*Motacilla citreola*	WM, C	0.0043
95		Paddyfield Pipit	*Anthus rufulus*	R, C	0.0111
96	**Monarchidae**	Asian Paradise Flycatcher	*Terpsiphone paradisi*	SM, r	0.0029
97	**Megalaimidae**	Coppersmith Barbet	*Megalaima haemocephala*	R, C	0.0065
98		Blue-throated Barbet	*Megalaima asiatica*	R, C	0.0043
99		Lineated Barbet	*Megalaima lineata*	R, C	0.0025
100		Great Barbet	*Megalaima virens*	R, r	0.0029
101	**Meropidae**	Green Bee-eater	*Merops orientalis*	R, C	0.0136
102		Blue-bearded Bee- eater	*Nyctyornisathertoni*	R, r	0.0047
103	**Nectariniidae**	Purple Sunbird	*Nectarinia asiatica*	R, r	0.0075
104		Crimson sunbird	*Aethopyga siparaja*	R, C	0.0039
105		Fire-tailed Sunbird	*Aethopyga ignicauda*	R, r	0.0014
106		Streaked Spider hunter	*Arachnothera magna*	R, r	0.0025
107		Little Spider hunter	*Arachnothera longirostra*	R, C	0.0022
108	**Oriolidae**	Black-headed oriole	*Oriolus xanthornus*	R, C	0.0104
109		Maroon Oriole	*Oriolus traillii*	R, C	0.0007
110	**Phasianidae**	Red Jungle Fow	*Gallus gallus*	R, C	0.0018
111		Grey Peacock Pheasant	*Polyplectron bicalcaratum*	R, r	0.0025
112		Black Francolin	*Francolinus francolinus*	R, C	0.0029
113		Swamp Francolin	*Francolinus gularis*	R, r, VU	0.0029
114	**Phalacrocoracidae**	Little Cormorant	*Microcarbo niger*	R, C	0.0043
115	**Psittacidae**	Rose-ringed Parakeet	*Psittacula krameri*	R, C	0.0162
116		Alexandrine Parakeet	*Psittacula eupatria*	R, C	0.0176
117		Red-breasted Parakeet	*Psittacula alexandri*	R, C	0.0075
118		Blossom-headed Parakeet	*Psittacula roseata*	R, r	0.0075
119	**Picidae**	Fulvous-breasted Woodpecker	*Dendrocopos macei*	R, r	0.0022
120		Grey-headed Woodpecker	*Picus canus*	R, r	0.0018
121		Greater Yellownape Woodpecker	*Picus flavinucha*	R, C	0.0065
122		Lesser Yellowenape Woodpecker	*Picus chlorolophus*	R, C	0.0029
123		Rufous Woodpecker	*Celeus brachyurus*	R, C	0.0054
124		Himalayan Flameback	*Dinopiumshorii*	R, C	0.0075
125		Greater Flameback	*Chrysocolaptes lucidus*	R, r	0.0029
126		Crimson-breasted Woodpecker	*Dendrocopos cathpharius*	R, r	0.0025
127		White-browed Piculet	*Sasia ochracea*	R, r	0.0018
128		Speckled Piculet	*Picumnus innominatus*	R, r	0.0011
129	**Pittidae**	Blue Pitta	*Pita cyanea*	R, r	0.0029
130		Blue-naped Pitta	*Pitta nipalensis*	R, r	0.0007
131	**Paridae**	Great Tit	*Parus major*	R, C	0.0043
132		Sultan Tit	*Melanochlora sultanea*	R, C	0.0018
133	**Phyllocopidae**	Grey-cheeked Warbler	*Seicercus poliogenys*	R, C	0.0054
134		Greenish Warbler	*Phylloscopu strochiloides*	WM, r	0.0025
135	**Pycnonotidae**	Red-vented Bulbul	*Pycnonotus cafer*	R, C	0.0434
136		Red-whiskered Bulbul	*Pycnonotus jocosus*	R, C	0.0320
137		Himalayan Bulbul	*Pycnonotus leucogenys*	R, r	0.0104

138		Striated Bulbul	*Pycnonotus striatus*	R, C	0.0029
139		Black Bulbul	*Hypsipetes leucocephalus*	R, r	0.0025
140		Black-crested Bulbul	*Pycnonotus melanicterus*	R, C	0.0022
141	**Passeridae**	House Sparrow	*Passer domesticus*	R, C	0.0359
142	**Ploceidae**	Baya Weaver	*Ploceus philippinus*	R, r	0.0057
143	**Saturnidae**	Common Myna	*Acridotheres tristis*	R, C	0.0539
144		Pied Myna	*Sturnus contra*	R, C	0.0377
145		Jungle Myna	*Acridotheres fuscus*	R, C	0.0014
146	**Sittidae**	Velvet-fronted Nuthatch	*Sitta frontalis*	R, C	0.0007
147		Chestnut-bellied Nuthatch	*Sitta castanea*	R, C	0.0007
148	**Strigidae**	Spotted Owlet	*Athene brama*	R, r	0.0011
149		Collared Owlet	*Glaucidium brodiei*	R, r	0.0007
150		Asian Barred Owlet	*Glaucidium cuculoides*	R, r	0.0007
151		Spotted Scops Owl	*Otus spilocephalus*	R, r	0.0007
152	**Scolopacidae**	Common Sandpiper	*Actitis hypoleucos*	WM, C	0.0014
153		Silver-eared Mesia	*Leiothrix argentauris*	R, C	0.0018
154		White-crested Laughing Thrush	*Garrulax leucolophus*	R, r	0.0007
155		White-throated Laughing thrush	*Garrulax albogularis*	R, r	0.0007
156		Rufous-vented Laughing Thrush	*Garrulax gularis*	R, C	0.0004
157		Rufous-necked Laughing Thrush	*Garrulax ruficollis*	R, r	0.0007
158		Blue Rock-Thrush	*Monticola solitarius*	WM, C	0.0011
159		Long-tailed Sibia	*Heterophasia picaodes*	R, C	0.0018
160		Beautiful Sibia	*Heterophasia pulchella*	R, r,En	0.0007
161		Common Tailorbird	*Orthotomus sutorius*	R, C	0.0122
162		Mountain Tailorbird	*Orthotomus cuculatus*	R, C	0.0007
163	**Turdidae**	Blue Whistling Thrush	*Myophonus caeruleus*	R, C	0.0054
164		Orange headed Thrush	*Zoothera citrina (SV)*	SM, r	0.0018
165		Scaly Thrush	*Zoothera dauma*	WM, C	0.0014
166	**Tichodromidae**	Wall creeper	*Tichodroma muraria*	W, V	0.0047
167	**Upupidae**	Hoopoe	*Upupa epops*	R, C	0.0068
168	**Zosteropidae**	Oriental white-eye	*Zosterops palpebrosus*	R, C	0.0104

R - Resident; C - Common; r - Rare; WM - Winter Migrant; SM - Summer Migrant; V - Vagrant; EN - Endangered; En - Endemic; NT - Near Threatened; VU - Vulnerable; CR -Critically Endangered; NR - New Record.

ANNEXURE II

Checlist of major herpetofauna found in the study area

S.N.	Scientific name	English Name	Local Name	Conservation Status
1.	*Amphiesma stolatum*	Buffsrtipped Keelback Snake	Bamuni Sanp	Schedule-IV
2.	*Bangurus bungaroides*	Banded Krait	Gaula	Schedule-III
3.	*Bungarus caeruleus*	Common krait	Sankhasur	-
4.	*Bungarus niger*	Black krait	Aalod	-
5.	Calotes versicolour	Garden lizard	Keko	-
6.	*Cuora amboinensis*	Box turtle	Kacha	-
7.	*Cyelemys oldhami*	Asian leaf turtle	Kacha	Schedule-IV
8.	*Gekko gecko*	Gecko	Keko	
9.	*Geochelone emys*	Brown tortories	Kacha	Schedule-IV
10.	*Geodemys hamitouii*	Pond turtle	Kacha	Schedule-I (P-II)
11.	*Hardella thurjii*	River turtle	Kacha	Schedule-IV
12.	*Hemidactylus flaviviridis*	Common house lizard	Keko	-
13.	*Kachuga tecta*	Roofed turtle	Kacha	Schedule-I (P-II)
14.	*Naja kouthia*	Monocoelate Cobra	Chakari Feti	Schedule-II
15.	Naja naja	Indian Cobra	Feti	Schedule-II
16.	*Ophiocephalus hannah*	King Cobra	Roja Feti	Schedule-II
17.	*Pangshura sylhetensis*	Assam roofed turtle	Kacha	
18.	*Ptyas mucosa*	Rat snake	Daras	Sch II (Part II)
19.	Python molurus	Indian python	Gom Feti	Schedule-I (P-II)
20.	*Rhabdophis subminiatus*	Red necked Keelback Snake	Batsupa	Schedule-IV
21.	*Trimeresurus gramineus*	Bamboo viper	Karsola	-
22.	*Trimeresurus medoensis*	Pit viper		-
23.	Tropidontus sp.	Pond snake		Schedule-II
24.	Typhlina bramima	Common blind snake	Khontia sanp	Schedule-IV
25.	*Varanus bengalensis*	Monitor lizard	Gui	Schedule-II
26.	*Varanus salvator*	Water monitor lizard	Pani gui	Schedule-II
27.	*Xanochrophis piscator*	Chekered Keelbacked	Kaudia dhora	Schedule-II

*Source of data: EIA/EMP reports of proposed Tikak and Lekhapani mine lease area

ANNEXURE III

Checklist of major insects found in the study area

Scientific/ common name	Order	Family
Acrida exaltata Walker	Orthoptera	Acridinae
Phlaeoba infumata Brunner	Orthoptera	Acridinae
Stenocatantops splendens Thunberg	Orthoptera	Acridinae
Gryllus splendens Thunberg	Orthoptera	Gryllidae
Grylotalpa sp.	Orthoptera	*Gryllotalpidae*
Oxya nitidula (walk)	Orthoptera	Acridinae
Oxya fuscovittata Marschall	Orthoptera	Acridinae
Oxya hyla hyla Serville	Orthoptera	Acridinae
Poekilocerus pictus Fabricius	Orthoptera	Acridinae
Heiroglyphus banian (Fab)	Orthoptera	Acridinae
Catantops pinguis (walk)	Orthoptera	Acridinae
Euconocephalus indicus (Redt)	Orthoptera	Tettiginidae
Phaneroptera sp.	Orthoptera	Tettiginidae
Trigonocoryapha unicolor	Orthoptera	Tettiginidae
Phlaeoba pictus.	Orthoptera	Acridinae
Diabolocatantops pinguis Walker	Orthoptera	Acrididae
Anax guttatus Burmeister	Odonata	Aeshnidae
Agriochemis pieris	Odonata	Zoraptera
Ceriagrion sp.	Odonata	Zoraptera
Solenopsis sp.	Hymenoptera	Formicidae
Myrmica sp.	Hymenoptera	Formicidae
Atta sp.	Hymenoptera	Formicidae
Bombus sp	Hymenoptera	Apidae
Apis dorsata	Hymenoptera	Apidae
Common wasp	Hymenoptera	Vespidae

ANNEXURE IV

Systematic list of butterflies recorded from the study area

S.N	English Name	Scientific Name	Relative Abundance	Status
1.	Common Fivering	*Ypthima baldus*	Very Common	-
2.	Punchinello	*Zemeros flegyas*	Very Common	-
3.	Common Grass Yellow	*Eurema hecabe*	Very Common	-
4.	Chocolate Albatross	*Appias lyncida*	Very Common	-
5.	Red Helen	*Papilio helenus*	Very Common	-
6.	Elbowed Pierrot	*Caleta elna*	Very Common	-
7.	Common Bushbrown	*Mycalesis perseus*	Very Common	-
8.	Common Emigrant	*Catopsila pomona*	Very Common	-
9.	Grey Count	*Tanaecia lepidea*	Very Common	-
10.	Chestnut Bob	*Lambrix salsala*	Very Common	-
11.	Common Lascar	*Pantoporia hordonia*	Very Common	-
12.	Common Sailer	*Neptis hylas*	Very Common	-
13.	Tawny Rajah	*Charaxes bernardus*	Very Common	-
14.	Unbroken Sergeant	*Athyma pravara*	Very Common	Endemic; IWPA Sch.II Part II
15.	Glassy Tiger	*Parantica aglea*	Very Common	-
16.	Common Line Blue	*Prosotas nora*	Very Common	-
17.	Watson's Bushbrown	*Mycalesis watsoni*	Very Common	Endemic
18.	Chocolate Royal	*Remelana jangala*	Very Common	Endemic
19.	Common Maplet	*Chersonesia risa*	Very Common	-
20.	Common Yamfly	*Loxura atymnus*	Very Common	-
21.	Branded Yamfly	*Yasoda tripunctata*	Very Common	Endemic; IWPA Sch.II Part II
22.	Light Straw Ace	*Pithauria stramineipennis*	Very Common	Endemic
23.	Spangle	*Papilio protenor euprotenor*	Very Common	-
24.	Bright Sunbeam	*Curetis bulis*	Very Common	-
25.	Common Tree Yellow	*Gandaca harina*	Very Common	Endemic
26.	Cruiser	*Vindula erota*	Very Common	-
27.	Leopard Lacewing	*Cethosia cyane*	Very Common	-
28.	Purple Sapphire	*Heliphorus epicles*	Very Common	-
29.	Fluffy Tit	*Zeltus amasa*	Very Common	-
30.	Indian Cabbage White	*Pieris canidia*	Very Common	-
31.	Straight Banded Treebrown	*Lethe verma*	Very Common	-
32.	Yellow Rajah	*Charaxes marmax*	Very Common	IWPA Sch.II Part II
33.	Five Bar Swordtail	*Graphium antiphates*	Very Common	-
34.	Red Tailed Forester	*Lethe sinorix*	Very Common	Endemic

35.	Tiger Hopper	*Ochus subvittatus*	Very Common	Endemic
36.	Chocolate Demon	*Anicistroides nigrita*	Common	-
37.	Common Evening Brown	*Melanitis leda*	Common	-
38.	Common Peacock	*Palipio paris*	Common	-
39.	Magpie Crow	*Euploea klugii*	Common	-
40.	Northern Spotted Ace	*Thoressa cerata*	Common	Endemic
41.	Raven	*Papilio castor*	Common	Endemic
42.	Yellow Orange Tip	*Ixias pyrene*	Common	-
43.	Dark Blue Tiger	*Tirumala septentrionis*	Common	-
44.	Golden Birdwing	*Troides aeacus*	Common	-
45.	Plain Bushbrown	*Telinga malsarida*	Common	Endemic; IWPA Sch.II Part II
46.	Popinjay	*Stibochiona nicea*	Common	-
47.	Red Base Jezebel	*Delias pasithoe*	Common	-
48.	Striped Tiger	*Danaus genutia*	Common	-
49.	Banded Lineblue	*Prosotas aluta coelestis*	Common	IWPA Sch.II Part II
50.	Common Batwing	*Atrophaneura varuna*	Common	-
51.	Common Cerulean	*Jamides celeno*	Common	-
52.	Common Hedge Blue	*Acytolepis puspa*	Common	-
53.	Common Mormon	*Papilio polytes romulus*	Common	-
54.	Common Palmfly	*Elymnias hypermnestra*	Common	-
55.	Common Pierrot	*Castalius rosimon*	Common	-
56.	Dusky Partwing/Coon	*Psolos fuligo subfasciatus*	Common	Endemic
57.	Dark Velvet Bob	*Koruthaialos butleri*	Common	Endemic
58.	Great Orange Tip	*Hebomoia glaucippe*	Common	-
59.	Tailed Jay	*Graphium agamemnon*	Common	-
60.	Commander	*Moduza procris*	Fairly Common	-
61.	Common Dartlet	*Oriens gola*	Fairly Common	-
62.	Common Jester	*Symbrenthia lilaea khasiana*	Fairly Common	-
63.	Common Yeoman	*Cirrochroa tyche*	Fairly Common	-
64.	Dark Catseye	*Zipaetis scylax*	Fairly Common	Endemic
65.	Great Eggfly	*Hypolimnas bolina*	Fairly Common	-
66.	Great Jay	*Graphium eurypylus*	Fairly Common	-
67.	Knight	*Lebadea martha*	Fairly Common	-
68.	Large Yeoman	*Cirrochroa aoris*	Fairly Common	-
69.	Rice Swift	*Borbo cinnara*	Fairly Common	-
70.	Small Yellow Sailer	*Neptis miah*	Fairly Common	-
71.	Staff Sergeant	*Athyma selenophora*	Fairly Common	-
72.	Swift	*Pelopidas* sp.	Fairly Common	-
73.	Water Snowflat	*Tagiades litigiosa*	Fairly Common	-
74.	Wizard	*Rhinopalpa polynice*	Fairly Common	Endemic; IWPA Sch.II Part II

75.	Angled Red Forester	*Lethe chandica*	Fairly Common	-
76.	Assam Flash	*Rapala tara*	Fairly Common	Endemic
77.	Black Forester	*Lethe vindhya*	Fairly Common	Endemic
78.	Chocolate Pansy	*Junonia iphita*	Fairly Common	-
79.	Common Acacia Blue	*Surendra quercetorum*	Fairly Common	-
80.	Common Blue Bottle	*Graphium sarpedon*	Fairly Common	-
81.	Common Imperial	*Cheritra freja*	Fairly Common	-
82.	Common Snowflat	*Tagiades japetus*	Fairly Common	-
83.	Dark Evening Brown	*Melanitis phedima*	Fairly Common	-
84.	Dingy Sailer	*Neptis pseudovikasi*	Fairly Common	-
85.	Dot-dash Sergeant	*Athyma kanwa*	Fairly Common	Endemic; IWPA Sch.II Part II
86.	Fulvous Piedflat	*Pseudocoladenia dan*	Fairly Common	-
87.	Great Archduke	*Lexias cyanipardus*	Fairly Common	Endemic
88.	Lime Swallowtail	*Papilio demoleus*	Fairly Common	-
89.	One Spot Grass Yellow	*Eurema andersonii*	Fairly Common	-
90.	Orchid Tit	*Hypolycaena othona*	Fairly Common	-
91.	Peacock Pansy	*Junonia almana*	Fairly Common	-
92.	Striped Blue Crow	*Euploea mulciber*	Fairly Common	IWPA Sch. IV
93.	Sullied Sailer	*Neptis clinia*	Fairly Common	-
94.	White Dargontail	*Lamproptera curius*	Fairly Common	Endemic
95.	Yellow Coster	*Acraea issoria*	Fairly Common	-
96.	Yellow Sailer	*Neptis ananta*	Fairly Common	-
97.	BushHopper	*Ampittia dioscorides*	Fairly Common	-
98.	Long-banded Silverline	*Spindasis lohita*	Fairly Common	-
99.	Common Nawab	*Polyura athamas*	Fairly Common	-
100.	Autumn Leaf	*Doleschallia bisaltide*	Uncommon	-
101.	Banded Ace	*Halpe zema*	Uncommon	Endemic
102.	Black Vein Sergeant	*Athyma ranga*	Uncommon	IWPA Sch.II Part-II
103.	Blue Spotted Crow	*Euploea midamus*	Uncommon	IWPA Sch.II Part-II
104.	Blue Tit	*Hypolycaena kina*	Uncommon	-
105.	Centaur Oakblue	*Arhopala centaurus*	Uncommon	-
106.	Chocolate Tiger	*Parantica melaneus*	Uncommon	-
107.	Colour Sergeant	*Athyma inara*	Uncommon	-
108.	Common Baron	*Euthalia aconthea*	Uncommon	-
109.	Common Ciliate Blue	*Anthene emolus*	Uncommon	-
110.	Common Earl	*Tanaecia julii*	Uncommon	-
111.	Common Gull	*Cepora nerissa*	Uncommon	-
112.	Common Lineblue	*Prosotas nora*	Uncommon	-
113.	Common Maplet	*Chersonesia risa*	Uncommon	-
114.	Common Rose	*Pachliopta aristolochiae*	Uncommon	-
115.	Common Sergeant	*Athyma perius*	Uncommon	-

116.	Common Spotted Flat	*Celaenorrhinus leucocera*	Uncommon	-
117.	Common Windmill	*Byasa polyeuctes*	Uncommon	-
118.	Courtsean	*Euripus nyctelius*	Uncommon	-
119.	Dark Archduke	*Lexias dirtea khasiana*	Uncommon	Endemic; IWPA Sch.II Part II
120.	Dark-branded Bushbrown	*Mycalesis mineus*	Uncommon	-
121.	Dingiest Sailer	*Neptis harita*	Uncommon	-
122.	Dusky Diadem	*Ethope himachala*	Uncommon	Endemic
123.	Extra Forest Bob	*Scobura cephala*	Uncommon	Endemic
124.	Great Evening Brown	*Melanitis zitenius*	Uncommon	-
125.	Great Mormon	*Papilio memnon*	Uncommon	-
126.	Grey Pansy	*Junonia atlites*	Uncommon	-
127.	Indian Awlking	*Choaspes benjaminii*	Uncommon	-
128.	Lilacine Bushbrown	*Mycalesis francisca*	Uncommon	-
129.	Orange Awlet	*Burara jaina*	Uncommon	-
130.	Pale Palm Dart	*Telicota colon*	Uncommon	-
131.	Pale Wanderer	*Pareronia avatar*	Uncommon	Endemic
132.	Pallid Nawab	*Charaxes arja*	Uncommon	Endemic
133.	Plain Sailer	*Neptis cartica*	Uncommon	Endemic
134.	Common Quaker	*Neopithecops zalmora*	Uncommon	-
135.	Restricted Demon	*Notocrypta curvifascia*	Uncommon	-
136.	Royal Cerulean	*Jamides caeruleus*	Uncommon	Endemic
137.	Tailed Judy	*Abisara neophron*	Uncommon	-
138.	Tailed Sulphur	*Dercas verhuelli*	Uncommon	-
139.	Veined Jay	*Graphium chironides*	Uncommon	-
140.	White-edged Blue Baron	*Euthalia phemius*	Uncommon	-
141.	Dark Yellow-banded Flat	*Celaenorrhinus aurivittata*	Uncommon	Endemic
142.	Yellow Flat	*Mooreana trichoneura*	Uncommon	-
143.	Yellow Helen	*Papilio nephelus*	Uncommon	IWPA Sch.II Part II
144.	Powdered Baron	*Euthalia monina*	Uncommon	-

*IWPA-Indian Wildlife (Protection) Act 1972/ Endemic-Endemic to North East India

ANNEXURE V

Comparative account of Fish diversity of Patkai Lake and Mota beel of syudy area *

SN	Name of the fish and family	Patkai lake	Motabeel
1	*Notopterus chitala (Ham.-Buch):* Notopteridae	---	+
2	*N. notopterus* (Pallas) *:* Notopteridae	---	+
3	*Salmostoma bacaila* (Ham.-Buch): Cyprinidae	---	+
4	*Rasabora rasbora* (Ham.-Buch) : Cyprinidae	---	+
5	*Bengala elanga (*Ham.-Buch) : Cyprinidae	---	+
6	*Amblypharyngodon mola* (Ham.-Buch) : Cyprinidae	+	+
7	*Cyprinus carpio (*Linn) : Cyprinidae	++	---
8	*Puntius chola (*Ham.-Buch) : Cyprinidae	---	+
9	*P. conchonius* (Ham.-Buch) : Cyprinidae	---	+
10	*P. sophore* (Ham.-Buch*.)* : Cyprinidae	---	+
11	*Labeo bata* (Ham.-Buch) : Cyprinidae	---	+
12	*L. calbasu* (Ham.-Buch) : Cyprinidae	---	++
13	*L. gonius* (Ham.-Buch.) : Cyprinidae	---	+
14	*L. rohita* (Ham.-Buch.) : Cyprinidae	---	++
15	*Cirrhina mrigala* (Ham.-Buch.) : Cyprinidae	++	+++
16	*C. reba* (Ham.-Buch) : Cyprinidae	---	+
17	*Catla catla* (Ham.-Buch.) : Cyprinidae	---	+
18	*Nemachelius botia* (Ham.-Buch.): Balitoridae	---	+
19	*Mystus cavasius* (Ham.-Buch.) : Bagridae	---	+
20	*M . seenghala* (Sykes) : Bagridae	---	++
21	*M . tengra* (Ham.-Buch*)* : Bagridae	---	+
22	*M. vittatus* (Bloch) : Bagridae	---	+
23	*Wallago attu* (Schneider) : Siluridae	---	+
24	*Channa punctatus* (Bloch) : Channidae	++	+++
25	*Clarias batrahcus* (Linn.) : Claridae	+++	+++
26	*Glossogobius guris* (Ham.-Buch.) : Gobidae	++	+++
27	*Heteropneustes fossilis* (Bloch*)* : Heteropneustidae	--	++
28	*Xenentodon cancila* (Ham.-Buch.) : Belonidae	--	++
29	*Colisa fasciatus* (Schneider) : Belonidae	--	+
30	*Channa punctatus* (Bloch) : Channidae	--	+++
31	*C. striatus* (Bloch) : Channidae	--	+
32	*Anabus testudineus* (Bloch) : Anabantidae	--	+
33	*Chanda nama* (Ham.-Buch.) : Chandidae	--	+
34	*C. ranga* (Ham.-Buch.) : Chandidae	--	+
35	*Macrognathaus aral* (Bloch- Schneider) : Mastacembellidae	--	+
36	*M. armatus* (Lacepede) : Mastacembellidae	--	+

NB: + indicates presence and – indicates absence

* Bhagbati and Borkotoki (2014)

ANNEXURE VI

Phytoplankton groups recorded in the study area*

Chlorophyceae	Desmidiaceae	Bacillariophyceae	Myxophyceae
Ankistrodesmus	*Arthrodesmus*	*Amphora*	*Anabaena*
Botryococcus	*Closterium*	*Cocconeis*	*Aphanocaspa*
Ceratium	*Cosmarium*	*Cyclotella*	*Coeiospherium*
Pediastrum	*Desmidium*	*Cymbella*	*Merismopodia*
Protococcus	*Euastrum*	*Diatoma*	*Nostoc*
Scenedesmum	*Gennicularia*	*Diatomella*	*Oscillatoria*
Spirogyra	*Micrasterius*	*Epithemia*	*Rivularia*
Synura	*Penium*	*Eunotia*	*Spirulina*
Ulotrix		*Fragillaria*	*Netrium*
Volvox		*Gomphonema*	*Xanthidium*
Zygnema		*Melosira*	*Tetradesmum*
		Meridion	*Microcystis*
		Navicula	*Chlamydomonas*
		Pinnularia	*Chodatella*
		Surirella	*Crucigenia*
		Synedra	*Chlamydomonas*
		Tabellaria	*Chodatella*
			Crucigenia
			Dictyosphaerium
			Dinobryon
			Euglena
			Hormidium
			Oedogonium

* Bhagbati and Borkotoki (2014)

ANNEXURE VII

Diversity of zooplankton recorded in patkai lake and mota beel in the study area*

Species	Mota beel	Patkai lake
Rotifera		
Brachionus angularis	+++	+
Brachionus calyciflorus	+	++
Brachionus caudatus aculeatus	+	+
Brachionus diersicornis	+	++
Brachionus quadridentata	--	+
Keratella cochlearis	+++	--
Keratella tropica	+++	+
Lecane lunaris	+	+
Lacane monostyla	+	++
Gastropus minor	--	+
Ascomorpha ovalis	+	++
Asplanchna sp	++	+
Synchaeta sp	+	+
Polyarthra vulgaris	--	+
Philodina citrine	+	+++
Cladocera		
Daphnia pulex	+	+++
Daphnia carinata	+	++
Monia micrua	--	+
Monia brachiata	+	+
Bosmina. Sp	+++	+
Alonella. Sp	+	+
Copepoda		
Cyclopoid copepodite	+	++
Diaptomus pallidus	+	++
Neodiaptomus sp	+	+
Cyclops sp	+++++++	++
Mesocyclops sp	+	+
Nauplius larva	+	+
Protozoa		
Paramecium caudatum	++	+++
Vorticella campanula	+	+++
Pandorina	+	++
Centropixis	+	+
Eudorina	--	+
Difflugia	++	--

NB: + indicates presence and – indicates absence

* Bhagbati and Borkotoki (2014)

ANNEXURE-VIII (A)

List of tree species found in the study area along with their family and Importance Value Index

SN	Species Name	Family	Vernacular Name	IVI
1	*Acer campbellii* Hook.f. & Thomson ex Hiern	Sapindaceae	Mota bhe	0.3
2	*Actinodaphne angustifolia* Nees	Lauraceae	Petarichawa	0.4
3	*Actinodaphne obovata* (Nees) Blume	Lauraceae	Pateri chowa	2.1
4	*Adina cordifolia* (Roxb.) Hook. f.	Rubiaceae	Haldi sopa	0.2
5	*Aglaia spectabilis* (Miq.) S.S.Jain & S.Bennet	Meliaceae	Amari/ Bandardima	0.3
6	*Ailanthus excelsa* Roxb.	Simaroubaceae	Borpat	2.3
7	*Ailanthus integrifolia* Lam.	Simaroubaceae	Koronga	3.0
8	*Alangium chinense* (Lour.) Harms	Simaroubaceae	Borpat	1.0
9	*Albizia chinensis* (Osbek) Merr.	Cornaceae	Chika morolia	0.3
10	*Albizia lebbeck* (L.) Benth.	Mimosaceae	Saw koroi	0.4
11	*Albizia myriophylla* Benth.	Mimosaceae	Siris	0.2
12	*Albizia procera* (Roxb) Benth.	Mimosaceae	Goroi/ Hitharu	0.3
13	*Albizia lucidior* (Steud.) I.C.Nielsen	Mimosaceae	Koroi	0.9
14	*Albizia saman* (Jacq.) Merr.	Mimosaceae	Moj	0.1
15	*Alstonia scholaris* (L.) R. Br.	Mimosaceae	Rain tree	1.2
16	*Altingia excelsa* Noronha	Apocynaceae	Chotiana	9.1
17	*Amoora wallichii* King	Altingiaceae	Jutuli	5.0
18	*Anthecephalus Chinensis* (Lamk.) A.Rich ex Walp.	Meliaceae	Amari	0.6
19	*Antidesma ghaesembilla* Gaertn.	Rubiaceae	Kodom /Roghu	0.1
20	*Antidesma montanum* Bl.	Euphorbiaceae	Helos	0.1
21	*Antidesma acidum* Retz.	Euphorbiaceae	Helos	0.1
22	*Antidesma bunius* (L.) Spreng.	Euphorbiaceae	Helos	0.5
23	*Aphanamixis polystachya* (Wall.) R.Parker	Euphorbiaceae	Helos	0.7
24	*Aporosa wallichii* Hook.f.	Meliaceae	Bandardima	0.2
25	Aralia montana Blume	Euphorbiaceae	Helos	0.4
26	*Ardisia macrophylla* Reinw. ex Blume	Araliaceae	-	0.2
27	*Ardisia solanacea* (Poir.) Roxb.	Primulaceae	Tulutha poka	0.1
28	*Artocarpus chama* Buch.-Ham.	Primulaceae	Tulutha poka	6.3
29	*Artocarpus lacucha* Buch.-Ham.	Moraceae	Sam kothal	0.7
30	*Baccaurea ramiflora* Lour.	Moraceae	Dewachali	2.7
31	*Bauhinia malabarica* Roxb.	Moraceae	Bohot	0.1
32	*Bauhinia variegata* L.	Euphorbiaceae	Leteku	0.1
33	*Beilschmiedia brandisii* Hook.f.	Caesalpiniaceae	Boga kanchan	0.5
34	*Bischofia javanica* Bl	Caesalpiniaceae	Kanchan	3.1
35	*Bombax ceiba* L.	Lauraceae	Leluk	1.1

36	*Boswellia serrata* Roxb. ex Colebr.	Euphorbiaceae	Urium	0.1
37	*Bridelia retusa* (L.) Spreng	Malvaceae	Simolu	0.2
38	*Bridelia stipularis* (L.) Bl.	Bursaraceae	Dhuna/ Guggul	0.1
39	*Bursera serrata* Wall. ex Colebr.	Euphorbiaceae	Kohir	1.8
40	*Butea monosperma* (Lamk.) Taub.	Euphorbiaceae	Mou hilikha	0.1
41	*Callicarpa arborea* Roxb.	Bursaraceae	Miritegga	6.8
42	*Canarium benghalense* Roxb.	Papilionaceae	Polash	0.1
43	*Canarium resiniferum* Bruce ex King	Verbenaceae	Maskoita	5.5
44	*Carallia brachiata* (Lour.) Merr.	Bursaraceae	Dhuna	0.3
45	*Caryota urens* L.	Bursaraceae	Dhuna	0.1
46	*Castanopsis armata* (Roxb.) Spach	Rhizophoraceae	Mahi thekara	3.8
47	*Castanopsis hystrix* Hook.f. & Thomson ex A. DC.	Arecaceae	Sewa	1.8
48	*Castanopsis indica* (Roxb. ex Lindl.) A.DC.	Fagaceae	Saru singori	10.6
49	*Castanopsis tribuloides* (Sm.) A.DC	Fagaceae	Doba singori	0.2
50	*Celastrus monosperma* Roxb.	Fagaceae	Hingori, Singori	0.1
51	*Celtis tetrandra* Roxb.	Fagaceae	Phul singori	0.2
52	*Chisocheton cumingianus* (C.DC.) Harms	Celestraceae	Bhum loti	0.4
53	*Chrysophyllum roxburghii* G.Don	Cannabaceae		0.1
54	*Chukrasia tabularis* A. Juss.	Meliaceae	Bandardima	3.4
55	*Cinnamomum glanduliferum* (Nees.) Meissn.	Sapotaceae	Bon pitha	0.3
56	*Cinnamomum bejolghota* (Buch.-Ham.) Sweet	Meliaceae	Bogi poma	1.6
57	*Cinnamomum glaucescens* (Nees) Hand-Mazz.	Lauraceae	Gon soroi	0.2
58	*Combretum accuminatum* Roxb.	Lauraceae	Pati hunda	0.2
59	*Cordia dichotoma* G.Forst.	Lauraceae	Gonsoroi	0.2
60	*Crateva nurvala* Buch.-Ham.	Boraginaceae	Gobarhuta	0.1
61	*Croton tiglium* L.	Capparaceae	Borun	0.1
62	*Croton roxburghii* Balak	Euphorbiaceae	Koni bih	1.3
63	*Crypteronia paniculata* Blume	Euphorbiaceae	Mahudi	0.2
64	*Cryptocarya amygdalina* Nees.	Penaeaceae	Gorumora	0.1
65	*Cyathea spinulosa* Wall. ex Hook.	Lauraceae	Bon jolokia	0.8
66	*Dalbergia assamica* Benth.	Cyathaceae	-	0.1
67	*Derris elliptica* (Wall.) Benth.	Papilionaceae	Koroi	0.1
68	*Dillenia indica* L.	Papilionaceae	Bokal bih,Etam Sali	2.0
69	*Dillenia pentagyna* Roxb.	Dillaniaceae	Ou tenga	0.2
70	*Dimocarpus longan* Lour.	Dillaniaceae	Oxi	0.2
71	*Dipterocarpus retusus* Bl.	Sapindaceae	Kath lichu/ bonlichu	40.2
72	*Drimycarpus racemosus* Hook. f.	Dipterocarpaceae	Holong	0.2
73	*Duabanga grandiflora* (DC.) Walp.	Anacardiaceae	Am chaleng	8.5
74	*Dysoxylum alliaria* (Buch.-Ham.) Balak.	Lythraceae	Khokon	0.4
75	*Dysoxylum binectariferum* (Roxb.) Hook. f.	Meliaceae	Bandardima	3.1

76	*Dysoxylum excelsum* Blume syn D.procerum	Meliaceae	Bandardima	5.4
77	*Dysoxylum reticulatum* King.	Meliaceae	Bandardima	0.1
78	*Ehretia acuminata* R.Br.	Meliaceae	Bandardima	0.1
79	*Elaeocarpus aristatus* Roxb.	Boraginaceae	Bual	0.1
80	*Elaeocarpus floribundus* Bl.	Elaeocarpaceae	Borsopa	0.6
81	*Elaeocarpus grandifolius* Kurz.	Elaeocarpaceae	Garela sopa	0.4
82	*Elaeocarpus rogusus* Roxb.	Elaeocarpaceae	Jalphai	0.3
83	*Elaeocarpus sikkimensis* Mast.	Elaeocarpaceae	Seleng	0.1
84	*Elaeocarpus sphaericus* (Gaertn.) K. Schumann.	Elaeocarpaceae	Rudraksha	3.5
85	*Elaeocarpus tectorius* (Lour.) Poir.	Elaeocarpaceae	Poreng	2.5
86	*Endospermum chinense* Benth.	Euphorbiaceae	Phul gamari	2.0
87	*Engelhardtia spicata* Lechen ex Blume	Juglandaceae	Ronga amari	0.4
88	*Erythrina indica* Lamk.	Papilionaceae	Modar	0.1
89	*Erythrina stricta* Roxb.	Papilionaceae	Modar	0.1
90	*Eugenia grandis* Wight.	Myrtaceae		0.1
91	*Eurya accuminata* DC	Theaceae	Murmuria	1.0
92	*Eurya japonica*Thunb.	Theaceae	Murmuria	0.3
93	*Evodia meliaefolia* Benth.	Rutaceae	Maiphak	0.1
94	*Evodia triphylla* DC	Rutaceae	-	0.1
95	*Ficus auriculata* Lour.	Moraceae	Atha dimoru	0.2
96	*Ficus benghalensis* L.	Moraceae	Borgas	0.4
97	*Ficus benjamina* L.	Moraceae	Jori	3.6
98	*Ficus hirta* Vahl.	Moraceae	Khongal dimoru	0.1
99	*Ficus hispida*Vahl.	Moraceae	khohota dimoru	0.6
100	*Ficus lepidosa* Wall	Moraceae	Dimoru	0.2
101	*Ficus nervosa* Hayne ex Roth.	Moraceae	Khori pati dimoru	0.2
102	*Ficus racemosa* L.	Moraceae	Mou dimoru	0.2
103	*Ficus religiosa* L.	Moraceae	Ahot	0.4
104	*Ficus rumphi* Bl.	Moraceae	Pakhori/Jhori	0.2
105	*Ficus semicordata* Buch-Ham ex J. E. Sm.	Moraceae	-	0.6
106	*Garcinia atroviridis* Griff ex T Anderson	Cluciaceae	-	0.8
107	*Garcinia cowa* Roxb ex DC	Cluciaceae	Kau thakera	0.1
108	*Garcinia kydia* Roxb.	Cluciaceae	Kuji thakera	0.2
109	*Garcinia lancifolia* Roxb.	Cluciaceae	Rupahi thekare	0.5
110	*Garcinia morella* (Gaertn) Desr.	Cluciaceae	Kuji thakera	0.1
111	*Garcinia pedunculata* Roxb.	Cluciaceae	Sochopa tenga	0.9
112	*Garcinia spicata* (Wight & Arn.) Hook f.	Cluciaceae	Bor thakera	0.1
113	*Garcinia xanthochymus* Hook f.	Cluciaceae	-	0.3
114	*Garcinia dulcis* (Roxb.) Kurz	Cluciaceae	Tepor	0.1
115	*Garcinioa paniculata* Roxb.	Euphorbiaceae	Pani chitiki	0.1

116	*Glochidion assamicum* Hook f.	Euphorbiaceae	Gorumora	0.4
117	*Glochidion multiloculare* (Wall.) Voigt.	Verbenaceae	Gomari	0.1
118	*Gmelina arborea* Roxb.	Tilaceae	Kukursuta	1.4
119	*Grewia disperma* Rottb.	Tilaceae	Kukursuta	0.2
120	*Grewia hirsuta* Vahl.	Tilaceae	Kukursita	0.3
121	*Grewia microcos* L.	Tilaceae	Kukursuta	0.6
122	*Gynocardia odorata* R. Br.	Flacourtiaceae	Lemtem	0.7
123	*Heteropanax fragrans* (Roxb.) Seem.	Araliaceae	Keseru	1.0
124	*Horsfieldia amygdalina* (Wall.) Warb.	Myristicaceae	Amol	0.1
125	*Horsfieldia kingii* (Hook.f.) Warb.	Myristicaceae	Amol	0.1
126	*Hydnocarpus kurzii* (King) Warb.	Flacourtiaceae	Salmugra	0.7
127	*Ilex godajam* Colebr. ex Hook.f.	Aquifoliaceae	Hati kerepa	0.6
128	*Kydia calycina* Roxb.	Malvaceae	Pichola	0.9
129	*Lagerstroemia speciosa* (L.) Pers.	Lythraceae	Azar	0.5
130	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Jia poma	0.3
131	*Laportea crenulata* Gaudich.	Urticaceae	Surat	0.1
132	*Leea asiatica* (L.) Ridsale	Leeaceae	Ahoi	0.2
133	*Leea indica* (Burm f) Merr.	Leeaceae	Kukura thangia	0.5
134	*Leea macrophylla* Roxb.	Leeaceae	-	0.5
135	*Lindera assamica* Kurz.	Lauraceae	Matabhe	0.3
136	*Lindera latifolia* Hook f & Th.	Lauraceae	-	0.8
137	*Litsea cubeba* (Lour.) Pers.	Lauraceae	Mejangkori	0.9
138	*Litsea elongata* Wall.	Lauraceae	Petari-sawa	0.1
139	*Litsea laeta* (Nees) Hook f.	Lauraceae	boin hualu	0.1
140	*Litsea lancifolia* (Roxb.) Wall	Lauraceae	Loban	0.1
141	*Litsea monopetala* (Roxb.) Pers.	Lauraceae	Sualu	2.0
142	*Litsea nitida* Roxb. Ex Wall.	Lauraceae	Kotholua	0.4
143	*Litsea salicifolia* (Roxb ex Nees) Hook f	Lauraceae	Digholoti	0.2
144	*Litsea sebifera* Pers.	Lauraceae	Neluka, Heluka	0.1
145	*Livistona jenkinsiana* R. Br.	Arecaceae	Tokou	0.5
146	*Macaranga denticulata* (Bl.) Muel. Arg	Euphorbiaceae	Jaglo/ Morolia	5.7
147	*Macaranga indica* Wight	Euphorbiaceae	Jaglo	1.4
148	*Maesa chisia* Buch.-Ham. ex D. Don	Primulaceae	Susu poroma	0.1
149	*Magnolia champaca* (L.) Baill. ex Pierre	Magnoliaceae	Titasopa	2.8
150	*Magnolia doltsopa* (Buch.-Ham. ex DC.) Figlar	Magnoliaceae	Sopa	0.2
151	*Magnolia griffithii* Hook.f. & Thomson	Magnoliaceae	Gahori sopa	1.7
152	*Magnolia hodgsonii* (Hook.f. & Thomson) H.Keng	Magnoliaceae	Borhomthuri	8.0
153	*Magnolia insignis* Wall.	Magnoliaceae	Phul sopa	0.6
154	*Magnolia mannii* (King) Figla	Magnoliaceae	Kothal sopa	0.5
155	*Magnolia montana* (Blume) Figlar	Magnoliaceae	Pan sopa	0.9

156	*Magnolia nilagirica* (Zenker) Figlar	Magnoliaceae	cheni champa	0.1
157	*Magnolia oblonga* (Wall. ex Hook.f. & Thomson) Figlar	Magnoliaceae	Bor sopa/kothal sopa	0.4
158	*Magnolia pterocarpa* Roxb.	Magnoliaceae	Pansopa	2.6
159	*Malia composita* Willd.	Meliaceae	-	0.1
160	*Mallotus ferrugineus* (Roxb.) Muel. Arg.	Euphorbiaceae	Morolia	3.8
161	*Mallotus phillipnensis* (Lamk) Muel. Arg.	Euphorbiaceae	Joroth	0.1
162	*Mangifera sylvatica* Roxb.	Anacardiaceae	Bon am	0.5
163	*Mansonia dipikae* Purkayastha	Sterculiaceae	Badam	0.3
164	*Memecylon umbellatum* Burm. f.	Melastomataceae	-	0.1
165	*Mesua ferrea* L.	Cluciaceae	Nahor	6.6
166	*Morus laevigata* Wall.	Moraceae	Bola	2.5
167	*Oroxylum indicum* (L.) Kurz	Bignoniaceae	Bhat ghila	0.1
168	*Osteodes paniculata* Bl.	Euphorbiaceae	-	1.4
169	*Persea bombycina* (King ex. Hook) Kostel	Lauraceae	Sum	0.3
170	*Persea gamblei* (King. ex. Hook. F.) Kostel	Lauraceae	Mejathi	0.1
171	*Phoebe attenuata* Nees.	Lauraceae	Bon sum	0.3
172	*Phoebe cooperiana* Kanjilal ex. Das	Lauraceae	Mekahi	0.5
173	*Phoebe goalparensis* Hutchinson	Lauraceae	Bonsom	2.5
174	*Polyalthia jenkinsii* Hook f & Th	Annonaceae	Koliori	0.2
175	*Premna latifolia* Roxb.	Verbenaceae	Gohora	0.1
176	*Premna milleflora* Cl.	Verbenaceae	Silguri	0.1
177	*Pterospermum acerifolium* (L.) Willd	Sterculiaceae	Hati porila	1.2
178	*Quercus semiserrata* Roxb.	Fagaceae	-	0.1
179	*Quercus serrata* Murray	Fagaceae	-	1.0
180	*Rhus succedanea* L.	Anacardiaceae	Am selenga	0.2
181	*Rhus javanica* L.	Anacardiaceae	-	2.1
182	*Sapium baccatum* Roxb.	Euphorbiaceae	Seleng/lewa	10.2
183	*Sapium eugenifolium* Buch-Ham	Euphorbiaceae	Korha	1.4
184	*Sapium sebiferum* Roxb.	Euphorbiaceae	-	0.3
185	*Sapium insigne* (Royle) Trimen	Euphorbiaceae	Moha kola	0.1
186	*Saurauia roxburghii* Wall.	Saurauiaceae	Bon posola	0.4
187	*Saurauia napaulensis* DC.	Saurauiaceae	-	0.5
188	*Saurauia pendula* Blume	Saurauiaceae	-	0.2
189	*Schima wallichii* (DC) Kuntze	Theaceae	Bhe, Naga bhe	9.9
190	*Senna siamea* (Lam.) H.S.Irwin & Barneby	Caesalpiniaceae	-	0.1
191	*Shorea assamica* Dyer	Dipterocarpaceae	Mekai	6.0
192	*Sloanea sterculiacea var. assamica* (Benth.) Coode	Elaeocarpaceae	Bandarnema/ Joba hingori	0.1
193	*Spathodea campanulata* P.Beauv.	Bignoniaceae	-	0.1

194	*Spondias pinnata* (L. f.) Kurz.	Anacardiaceae	Amora	0.4
195	*Spondias axillaris* Roxb.	Anacardiaceae	Neem tenga	0.7
196	*Sterculia alata* Roxb.	Sterculiaceae	-	0.6
197	*Sterculia villosa* Roxb.	Sterculiaceae	Udal	2.8
198	*Stereospermum chelonoides* (L.f.) DC.	Bignoniaceae	Dhopa paroli	2.5
199	*Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	Bignoniaceae	Paroli	2.4
200	*Symplocos glauca* (Thunb.) Koidz.	Symplocaceae	-	0.1
201	*Symplocos oxyphylla* Wall.	Symplocaceae	-	0.1
202	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamu	0.1
203	*Syzygium fruticosum* DC.	Myrtaceae	Kothia Jamu	0.1
204	*Syzygium kurzii* (Duthie) N.P.Balakr.	Myrtaceae	Bogi jamu	0.2
205	*Syzygium operculatum* (Roxb.) Nied	Myrtaceae	-	1.1
206	*Tectona grandis* L. f.	Verbenaceae	Segun (Planted)	0.4
207	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Bhomora	8.0
208	*Terminalia chebula* Retz.	Combretaceae	Silikha	2.1
209	*Terminalia citrina* Roxb. ex Fleming	Combretaceae	Silikha	0.9
210	*Terminalia myriocarpa* Van Heurck & Müll. Arg.	Combretaceae	Holokh	3.1
211	*Tetrameles nudiflora* R. Br.	Datiscaceae	Bhelew	0.2
212	*Toona ciliata* M. Roem.	Meliaceae	Poma	0.3
213	*Trema orientalis* (L.) Blume	Cannabaceae	Phakdema	1.3
214	*Trevesia palmata* (Roxb. ex Lindl.) Vis.	Araliaceae	Bhotola	0.4
215	*Vatica lanceifolia* (Roxburgh) Blume	Dipterocarpaceae	Morsal	9.3
216	*Vitex glabrata* R.Br.	Lamiaceae	Pani amara	0.1
217	*Vitex peduncularis* Wall. ex Schauer	Lamiaceae	Ahoi/Sila	0.1
218	*Walsura robusta* Roxb.	Meliaceae	Lali	1.7
219	*Wrightia coccinea* (Roxb. ex Hornem.) Sims	Apocynaceae	-	0.1
220	*Zanthoxylum rhetsa* DC.	Sapindaceae	Mota bhe	0.1

Annexure-VIII (B)

List of species found in shrub layer

S.No.	Name of species	Family	
1	*Abelmoschus moschatus* Medik.	Malvaceae	shrubs
2	*Abroma augusta* (L.) L. f.	Sterculiaceae	Shrub
3	*Alangium chinense* (Lour.) Harms	Cornaceae	Small tree/Shrub
4	*Antidesma acidum* Retz.	Phyllanthaceae	Shrub
5	*Antidesma bunius* (L.) Spreng.	Phyllanthaceae	Shrub
6	*Aralia montana* Blume	Araliaceae	Small tree/Shrub
7	*Ardisia depressa* C.B.Clarke	Primulaceae	Shrub
8	*Ardisia humilis* Vahl	Primulaceae	Shrub
9	*Ardisia macrocarpa* Wall.	Primulaceae	Small tree/Shrub
10	*Ardisia paniculata* Roxb.	Primulaceae	Shrub
11	*Ardisia solanacea* (Poir.) Roxb.	Primulaceae	Shrub
12	*Boehmeria nivea* (L.) Gaudich.	Urticaceae	Shrub
13	*Boehmeria polystachya* Wedd.	Urticaceae	Shrub
14	*Calamus erectus* Roxb.	Arecaceae	Shrub
15	*Calamus floribundus* Griff.	Arecaceae	Stragling shrub
16	*Calamus gracilis* Roxb.	Arecaceae	Stragling shrub
17	*Calamus latifolius* Roxb.	Arecaceae	Stragling shrub
18	*Calamus tenuis* Roxb.	Arecaceae	Stragling shrub
19	*Calamus flagellum* Griff. ex Mart.	Arecaceae	Stragling shrub
20	*Calamus kingianus* Becc.	Arecaceae	Stragling shrub
21	*Calamus nambariensis* Becc.	Arecaceae	Stragling shrub
22	*Callicarpa longifolia* Lam.	Verbenaceae	Shrub
23	*Camellia sinensis var. assamica (J.W.Mast.) Kitam*	Theaceae	Shrub
24	*Canthium gracilipes* Kurz	Rubiaceae	Stragling shrub
25	*Capparis olacifolia* Hook. f. & Thomson	Capparaceae	Stragling shrub
26	*Casearia tomentosa* Roxb.	Salicaceae	Shrub
27	*Casearia vareca* Roxb.	Salicaceae	Shrub
28	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Asteraceae	Shrub
29	*Cissus repens* Lamk.	Vitaceae	Stragling shrub
30	*Clerodendrum cephalanthum* Oliv.	Lamiaceae	Stragling shrub
31	*Clerodendrum glandulosum* Lindl.	Lamiaceae	Shrub
32	*Clerodendrum infortunatum* L.	Lamiaceae	Shrub
33	*Clerodendrum serratum* (L.) Moon	Lamiaceae	Shrub
34	*Combretum acuminatum* Roxb.	Combretaceae	Stragling shrub
35	*Costus speciosus* (J.Koenig) Sm.	Costaceae	Stragling shrub
36	*Croton caudatus* Geiseler	Euphorbiaceae	Climber
37	*Cyathea spinulosa* Wall. ex Hook.	Cyathaceae	Shrub
38	*Dalbergia stipulacea* Roxb.	Papilionaceae	Stragling shrub
39	*Dalhousiea bracteata* (Roxb.) Benth.	Papilionaceae	Stragling shrub

40	*Dracaena angustifolia* (Medik.) Roxb.	Aspergaceae	Shrub
41	*Elaeagnus caudata* Schltdl. ex Momiy.	Elaeagnaceae	Stragling shrub
42	*Entada pursaetha* DC	Mimosaceae	Stragling shrub
43	*Eugenia balsamea* Wight	Myrtaceae	Shrub
44	*Fagerlindia fasciculata*(Roxb.) Tiruveng	Rubiaceae	Shrub
45	*Ficus hederacea* Roxb.	Moraceae	Stragling shrub
46	*Glochidion multiloculare* (Rottler ex Willd.) Voigt	Phyllanthaceae	Small tree/shrub
47	*Glochidion varians* Miq.	Phyllanthaceae	Small tree/shrub
48	*Glycosmis pentaphylla* (Retz) DC.	Rutaceae	Shrub
49	*Gnetum gnemon* L.	Gnetaceae	Shrub
50	*Gnetum montanum* Markgraf	Gnetaceae	Stragling shrub
51	*Grewia hirsuta* Vahl	Malvaceae	Small tree/shrub
52	*Grewia multiflora* Juss.	Malvaceae	Small tree/shrub
53	*Grewia nervosa* (Lour.) Panigrahi	Malvaceae	Small tree/shrub
54	*Grewia polygama* Roxb.	Malvaceae	Small tree/shrub
55	*Hedychium gardenerianum* Rosc.	Zingiberaceae	Shrub
56	*Hedychium spicatum* Buch-Ham ex Sm	Zingiberaceae	Shrub
57	*Hedychium stenopetalum*Lodd.	Zingiberaceae	Shrub
58	*Holmskioldia sanguinea* Retz.	Lamiaceae	Stragling shrub
59	*Hovenia dulcis* Thunb.	Rhamnaceae	Shrub
60	*Ichnocarpus frutescens* (L.) W.T.Aiton	Apopcynaceae	Shrub
61	*Knoxia mollis* R.Br. ex Wight & Arn.	Rubiaceae	Shrub
62	*Lantana camara* L.	Verbenaceae	Shrub
63	*Laportea crenulata* Gaudich.	Urticaceae	Shrub
64	*Leea asiatica* (L.) Ridsdale	Vitaceae	Shrub
65	*Leea indica* (Burm. f.) Merr.	Vitaceae	Shrub
66	*Leea macrophylla* Roxb. ex Hornem.	Vitaceae	Shrub
67	*Leea sambucina* Blanco	Vitaceae	Shrub
68	*Licuala peltata* Roxb. ex Buch.-Ham.	Arecaceae	Shrub
69	*Litsea salicifolia* (J. Roxb. ex Nees) Hook. f.	Lauraceae	Shrub
70	*Manihot esculenta* Crantz	Apopcynaceae	Shrub
71	*Melastoma malabathricum* L.	Malastomaceae	Shrub
72	*Micromelum pubescens* Blume	Rutaceae	Small tree/shrub
73	*Mimosa himalayana* Gamble	Mimosaceae	Stragling shrub
74	*Morinda angustifolia* Roxb.	Rubiaceae	Shrub
75	*Mucuna birdwoodiana* Tutcher	Papilionaceae	Stragling shrub
76	*Mussaenda frondosa* L.	Rubiaceae	Shrub
77	*Mussaenda roxburghii* Hook f.	Rubiaceae	Shrub
78	*Oxyspora paniculata* (D. Don) DC.	Malastomaceae	Shrub
79	*Pandanus fascicularis* Lam.	Pandanaceae	Shrub
80	*Phragmites karka* (Retz.) Trin. ex Steud.	Poaceae	Shrub
81	*Phlogacanthus curviflorus* (Wall.) Nees	Acanthaceae	Shrub
82	*Phrynium placentarium* (Lour.) Merr.	Marantaceae	Shrub

83	*Pinanga gracilis* Blume	Arecaceae	Shrub
84	*Prunus jenkinsii* Hook.f. & Thomson	Rosaceae	Shrub
85	*Saccharum spontaneum* L.	Poaceae	Shrub
86	*Salacca secunda* Griff.	Arecaceae	Shrub
87	*Saprosma ternatum* Hook f.	Rubiaceae	Shrub
88	*Saurauia napaulensis* DC.	Saurauiaceae	Shrub
89	*Saurauia pendula* Blume	Saurauiaceae	Shrub
90	*Saurauia roxburghii* Wall.	Saurauiaceae	Shrub
91	*Schefflera impressa* (C.B.Clarke) Harms	Araliaceae	Shrub/ Small tree
92	*Schefflera venulosa* (Wight & Arn.) Harms	Araliaceae	Stragling shrub
93	*Solanum torvum* Sw.	Solanacea	Shrub
94	*Sterculia coccinea* Roxb. Ex G Don	Sterculiaceae	Shrub
95	*Sterculia hymenocalyx* K. Schum.	Sterculiaceae	Shrub
96	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Apopcynaceae	Shrub
97	*Tetracera indica* (Christm. & Panz.) Merr.	Dillaniaceae	Stragling shrub
98	*Tetracera sarmentosa* (L.) Vahl	Dillaniaceae	Stragling shrub
99	*Tetrastigma thomsonianum* Planch.	Vitaceae	Stragling shrub
100	*Thunbergia grandiflora* (Roxb. ex Rottl.) Roxb.	Acanthaceae	Stragling shrub
101	*Thysanolaena maxima* (Roxb.) Kuntze	Poaceae	Shrubs
102	*Urena lobata* L	Maliaceae	shrub
103	*Zanthoxylum nitidum* (Roxb.) DC.	Rutaceae	Stragling shrub

Annexure-VIII (C)

List of species found in Herb layer

SN	Species	Family	Status
1	*Abacopteris lakhimpurensis*	Thelypteridaceae	Common
2	*Achyranthes aspera*	Amaranthaceae	Common
3	*Adiantum caudatum*	Pteridaceae	Common
4	*Ageratum conyzoides*	Asteraceae	Common
5	*Ageratum houstonianum*	Asteraceae	Common
6	*Alocasia spp*	Araceae	Common
7	*Alpinia allughas*	Zingiberaceae	Common
8	*Alpinia galanga*	Zingiberaceae	Common
9	*Amischotolype dolichandra*	Commelinaceae	Common
10	*Ampelopteris prolifera*	Thelypteridaceae	Common
11	*Amphineuron opulentum*	Thelypteridaceae	Common
12	*Angiopteris evecta*	Marantaceae	Common
13	*Anoectochilus sikkimensis*	Orchidaceae	Common
14	*Anthurium spp.*	Araceae	Common
15	*Asplenium nidus*	Aspleniaceae	Common
16	*Asplenium rhizophyllum*	Aspleniaceae	Common
17	*Axonopus compressus*	Poaceae	Common
18	*Axonopus spp*	Poaceae	Common
19	*Begonia roxburghii*	Begoniaceae	Common
20	*Blumea fistulosa*	Asteraceae	Common
21	*Blumea lacera*	Asteraceae	Common
22	*Borreria articularis*	Rubiaceae	Common
23	*Borreria hispida*	Rubiaceae	Common
24	*Canna spp*	Cannaceae	Common
25	*Cenchrus ciliaris*	Poaceae	Common
26	*Centotheca lappacea*	Poaceae	Common
27	*Cissampelos pareira*	Menispermaceae	Common
28	*Cissus repens*	Vitaceae	Common
29	*Coccinia grandis*	Cucurbitaceae	Common
30	*Colocasia sp.*	Araceae	Common
31	*Commelina spp.*	Commelinaceae	Common
32	*Costus speciosus*	Costaceae	Common
33	*Curculigo orchioides*	Hypoxidaceae	Common
34	*Curcuma spp.*	Zingiberaceae	Common
35	*Cyclosorus dentatus*	Thelypteridaceae	Common
36	*Cyperus spp*	Cyperaceae	Common
37	*Cyphostemma spp*	Vitaceae	Common
38	*Cyrtococcum accrescens*	Poaceae	Common
39	*Dicliptera roxburghii*	Acanthaceae	Common
40	*Digitaria ciliaris*	Poaceae	Common
41	*Digitaria spp*	Poaceae	Common

42	*Dioscorea pentaphylla*	Dioscoreaceae	Common
43	*Dioscorea procera*	Dioscoreaceae	Common
44	*Dioscorea spp*	Dioscoreaceae	Common
45	*Diplazium asperum*	Athyriaceae	Common
46	*Diplazium spp*	Athyriaceae	Common
47	*Drymaria cordata*	Caryophyllaceae	Common
48	*Drynaria quercifolia*	Polypodiaceae	Common
49	*Drynaria spp.*	Caryophyllaceae	Common
50	*Eclipta spp.*	Asteraceae	Common
51	*Eragrostis gangetica*	Poaceae	Common
52	*Floscopa spp*	Commelinaceae	Common
53	*Gleichenia linearis*	Gleicheniaceae	Common
54	*Gleichenia longissima*	Gleicheniaceae	Common
55	*Gleichenia microphylla*	Gleicheniaceae	Common
56	*Hedychium spp.*	Zingiberaceae	Common
57	*Heliotropium indicum*	Boraginaceae	Common
58	*Heteropogon contortus*	Poaceae	Common
59	*Homalomena aromatica*	Araceae	Common
60	*Impatiens tripetala*	Balsaminaceae	Common
61	*Kaempferia rotunda*	Zingiberaceae	Common
62	*Lepidagathis incurva*	Acanthaceae	Common
63	*Lippia javanica*	Verbenaceae	Common
64	*Lycopodium pimpinellifolium*	Lycopodiaceae	Common
65	*Lycopodium serratum*	Lycopodiaceae	Common
66	*Lygodium flexuosum*	Lycopodiaceae	Common
67	*Merremia umbellata*	Convolvulaceae	Common
68	*Microsorum punctatum*	Polypodiaceae	Common
69	*Mikania micrantha*	Asteraceae	Common
70	*Mollugo pentaphylla*	Molluginaceae	Common
71	*Mucuna prurita*	Leguminosae	Common
72	*Murdannia nudiflora*	Commelinaceae	Common
73	*Oplismenus burmannii*	Poaceae	Common
74	*Oplismenus compositus*	Poaceae	Common
75	*Oplismenus longifolium*	Poaceae	Common
76	*Paederia foetida*	Rubiaceae	Common
77	*Panicum indicum*	Poaceae	Common
78	*Phrynium placentarium*	Marantaceae	Common
79	*Phrynium acuminatum*	Marantaceae	Common
80	*Phrynium capitatum*	Marantaceae	Common
81	*Piper griffithii*	Piperaceae	Common
82	*Piper sylvatica*	Piperaceae	Common
83	*Piper thomsonii*	Piperaceae	Common
84	*Polygonum chinense*	Polygonaceae	Common
85	*Pothos cathcartii*	Araceae	Common
86	*Pothos scandens*	Araceae	Common

87	*Pteris cretica*	Pteridaceae	Common
88	*Pteris semipinnata*	Pteridaceae	Common
89	*Pyrrosia longifolia*	Polypodiaceae	Common
90	*Rhynchoglossum spp*	Gesneriaceae	Common
91	*Rubia cordifolia*	Rubiaceae	Common
92	*Scirpus juncoides*	Cyperaceae	Common
93	*Selaginella spp*	Selaginellaceae	Common
94	*Setaria palmifolia*	Poaceae	Common
95	*Spermacoce hispida*	Rubiaceae	Common
96	*Sporobolus spp*	Poaceae	Common
97	*Stenochlaena palustris*	Blechnaceae	Common
98	*Stephania japonica*	Menispermaceae	Common
99	*Urtica spp*	Urticaceae	Common
100	*Vitis japonica*	Vitaceae	Common
101	*Zingiber purpureum*	Zingiberaceae	Common
102	*Zingiber rubens*	Zingiberaceae	Common
103	*Zingiber zerumbet*	Zingiberaceae	Common
104	*Adiantum capillus-veneris*	Pteridaceae	Least Concern
105	*Commelina benghalensis*	Commelinaceae	Least Concern
106	*Cyperus pilosus*	Cyperaceae	Least Concern
107	*Desmodium adscendens*	Leguminosae	Least Concern
108	*Diplazium esculentum*	Athyriaceae	Least Concern
109	*Erianthus ravennae*	Poaceae	Least Concern
110	*Lasia spinosa*	Araceae	Least Concern
111	*Lindernia crustacea*	Linderniaceae	Least Concern
112	*Lindernia viscosa*	Linderniaceae	Least Concern
113	*Ludwigia octovalvis*	Onagraceae	Least Concern
114	*Mimosa pudica*	Leguminosae	Least Concern
115	*Paspalum conjugatum*	Poaceae	Least Concern
116	*Paspalum scrobiculatum*	Poaceae	Least Concern
117	*Phragmites karka*	Poaceae	Least Concern
118	*Polygonum barbatum*	Polygonaceae	Least Concern
119	*Polygonum hydropiper*	Polygonaceae	Least Concern
120	*Polygonum plebeium*	Polygonaceae	Least Concern
121	*Saccharum spontaneum*	Poaceae	Least Concern

ANNEXURE-IX

Table (A) Details of Pioneer tree species indicating planting techniques and their usages

S.No.	Species	Local name	Fruit collection season	Seed longevity	Sowing season	Germina-tion %	Planting season	Method of Planting	Use
1	*Macaranga indica*	Jaglo	Oct.-Nov.	(1-6 month)	Soon after collection	30-50%	June-July	Direct sowing, Entire planting, Branch cutting	Fuel wood
2	*Macaranga denticulata*	Morialia	May-Oct.	(1-6 month)	Soon after collection	30-50%	June-July	Direct sowing, Entire planting, Branch cutting	Fuel wood
3	*Callicarpa arborea*	Bon-mola	-	-	Feb.	78%	June-July	Direct sowing, Entire planting, Branch cutting	Fuel wood
4	*Trema orientalis*	Jopang/Sobai-goch	Dec.-May	Upto one month		70 - 80%	June-July	Direct sowing, Entire planting,	fodder
5	*Mallotus tertracoccus*	Loru-bondha	March-April	-	Soon after collection	30-40%	June-July	Direct sowing, Entire planting, Branch cutting	food for birds
6	*Schima wallichii*	Noga-bhar/pani-bokuli jirkiri	Feb-March	1-6 month	Soon after collection	30-40%	June-July	Direct sowing, Entire planting, Branch cutting	Fuel wood
7	*Sterculia villosa*	Odal	June	upto 1 year	Soon after collection	60-70%	June-July	Direct sowing, Entire planting	Fuel wood
8	*Stereospermum chelonoides*	Dhopa tita/ paroli	Jan-April	1 year	April-May	30-40%	June-July	Direct sowing, Entire planting	Fuel wood
11	*Albizia chinensis*	Sao-koroi	Jan	1 year	March	30-50%	June-July	Direct sowing, Entire planting	Fuel wood
12	*Albizia lebbeck*	Sirish/Kothiya-koroi	Dec.-Jan	2 year	March	30-50%	June-July	Direct sowing, Entire planting	Fuel wood
13	*Albizia procera*	Koroi	April-may	2 year	May	30-50%	June-July	Direct sowing, Entire planting	Fuel wood
14	*Bombax ceiba*	Silk cotton tree	March-May	2 year	-	14-75%	June-July	Direct sowing, Entire planting	Fuel wood
15	*Albizia lucidior*	Potka siris	Feb-April	1-6 month	May	50-55%	June-July	Direct sowing, Entire planting	Fuel wood

B. Details of Secondary tree species indicating planting techniques and their usages

Purpose	Species	Local name	Fruit collection season	Seed longevity	Sowing season	Germination %	Planting season	Method of Planting
Food species for primates	*Artocarpus chama*	Chamkathal	April-May	Short lived (1-6 months)	Soon after collection	50-60	June-July	Direct sowing, Entire planting
	Artocarpus gomezianus	Kharika-dewa	April-May	Short lived (1-6 months)	Soon after collection	50-60	June-July	Direct sowing, Entire planting
	Artocarpus lacucha	Bahat	April-May	Short lived (1-6 months)	Soon after collection	50-60	June-July	Direct sowing, Entire planting
	Mangifera sylvatica	Bon-aam	May-June	Short lived (1-6 months)	Soon after collection	30-50	June-July	Direct sowing, Entire planting
	Magnolia oblonga	Tita-sopa	March-May	Short lived (1-6 months)	Soon after collection	60-70	July	Direct sowing, Entire planting, Branch cutting
	Mesua ferrea	Nahar	May- June	Short lived (1-6 months)	Soon after collection	-	July	Direct sowing, Entire planting, Branch cutting
	Dillenia indica	Ou-tenga	Dec-Feb.	-	May	3-5	June-July	Direct sowing
	Dillenia pentagyna.	Ou-bonsolata	Dec-Feb.	-	May	3-5	June-July	Direct sowing
Fodder species	*Bauhinia variegata*	Kotora	May-June	Moderate long lived	May	95	June-July	Direct sowing, Entire planting
	Morus alba	Sahtut	April-May	Short lived (1-6 months)	Soon after collection	40	June-July	Direct sowing, Entire planting,
	Eurya accuminata	-	March-April	-	-	60	June-July	Direct sowing, Entire planting,
	Mallotus phillipnensis	Kamala- tree	March-April	June Short lived (1	April	20-30	June-July	Direct sowing, Entire planting
	Malia composita	Bokin	April-May	One year	Feb-March	65-70	July	Direct sowing, Entire planting
	Quercus serrata	-	Nov-Dec.	Up to one month	Soon after collection	10-15	June-July	Direct sowing, Entire planting
Key stone species	*Ficus benghalensis*	Bor-goch	March-July	30 days	Soon after collection	25-30	June-July	Direct sowing, Entire planting
	Ficus benjamina	Bor	March- July	30 days	Soon after	20-25	June-July	Direct sowing,

					collection			Entire planting
	Ficus religiosa	Anhat	March- July	30 days	Soon after collection	20-30	June-July	Direct sowing, Entire planting
	Ficus racemosa	Dimoru	March- July	30 days	Soon after collection	25-30	June-July	Direct sowing, Entire planting
	Castanopsis indica	Hingori	May	Moderate long lived	June	90	June-July	Direct sowing, Entire planting
Timber yielding species	*Aglaia spectabilis*	Amari	Sept.-Oct	Short lived (1-6 months)	Soon after collection	60	June-July	Direct sowing, Entire planting
	Saurauia roxburghii	Bon-posola	April-May	-	Soon after collection	-	June-July	Direct sowing, Entire planting,
	Kydia calycina	Pichola	Feb.-March	Short lived (1-6 months)	Soon after collection	60	June-July	direct sowing, Entire planting
	Altingia excelsa	Singri	May-June	Short lived (1-3 months)	Soon after collection	40-50	July	Direct sowing, Entire planting
	Shorea assamica	Mekai	March	One week	March	80-85	June-July	Direct sowing, Entire planting
	Terminalia myriocarpa	Holock	Oct. -Nov.	Very long lived(2years)	soon after collection	75	June-July	Direct sowing, Entire planting
	Duabanga grandiflora	Khukan	April- May	-	-	70	June-July	Direct sowing, Entire planting
	Dipterocarpus retusus	Hollong	Feb-march	7-10	March-April	50-60	May-June	Direct sowing, Entire planting
	Anthocephalus chinensis	Roghu	August-September	One year	Feb-March	80-90	June-July	Direct sowing, Entire planting
	Magnolia champaca	Tia-sopa	August	Short lived (1-3 months)	August-sept.	70-80	June-July	Direct sowing, Entire planting
Medicinally important species	*Terminalia bellirica*	Bhamora	Nov-Feb.		March -may	35-60	June-July	Direct sowing, Entire planting
	Oroxylum indicum	Bhat-ghila	Dec-July	Short lived (1-6 months)	Soon after collection	50	July-August	Direct sowing, Entire planting
	Syzygium cumini	Jam	June-August	15 days	June-July	20-90	July-August	Direct sowing, Entire planting
	Syzygium fruticosum	Jam	June-August	15 days	June-July	20-90	July-August	Direct sowing, Entire planting
	Terminalia chebula	Halikara		1year	June-July	50-60	June-July	Direct sowing, Entire planting

	Terminalia arjuna	Arjun	April-May	-	June-July		June-July	Direct sowing, Entire planting
	Aegle marmelos	Bael	March-may	-	June-July		June-July	Direct sowing, Entire planting
Avenue plantation	*Lagerstroemia speciosa*	Ajhar	Dec-Feb.	2 year	Feb-march	60-80	June	Direct sowing, Entire planting
	Delonix regia	Krishnasura	April-may	2-3 year	Sept-Oct.	30-40	June-July	Direct sowing, Entire planting
	Peltophorum pterocarpum	Copperpod	January to March	More than one year	June-July	8-10	June-July	Direct sowing, Entire planting
	Alstonia scholaris	Sattni	March April	1 month	April may		July	Direct sowing, Entire planting

C. Species wise details of Grasses indicating planting methods and their usages

S.No.	Species	Local Name	Planting methods	Specific feature
1	*Digitaria ciliaris*		Through seeds	Good forage value, germinates from topsoil seed bank
2	*Digitaria longiflora*		Through seeds	Good forage value, germinates from topsoil seed bank
3	*Oplismenus minuta*		Through seeds, root suckers	Good forage value, germinates from topsoil seed bank
4	*Oplismenus burmannii*	Banh-potia-bon	Through seeds, root suckers	Good forage value, germinates from topsoil seed bank
5	*Oplismenus compositus*	Banh-potia-bon	Through seeds, root suckers	Good forage value, germinates from topsoil seed bank
6	*Panicum incisum*		Through seeds, root suckers	Good forage value, germinates from topsoil seed bank
7	*Paspalum conjugatum*		Through seeds,	Good forage value, germinates from topsoil seed bank tolerant of poor, acid soils
8	*Paspalum scrobiculatum*	Kodoa-dhan	Through seeds,	can survive well on marginal soils
9	*Phragmites karka*	Nal-khagra	Through seeds, root suckers	It turns garbage into compost-like material that can be used as a soil conditioner.
10	*Saccharum spontaneum*	Kahua	Through seeds, root suckers	can succeed in wetter soils and are tolerant of seasonal inundation of the soil, can tolerate pH of 4.5 - 7.5
11	*Cenchrus ciliaris*		Through seeds, root suckers	Good forage value, drought tolerant, tolerant of fire, does not withstand waterlogging
12	*Centotheca lappacea*		Through seeds, root suckers	Good forage value, germinates from topsoil seed bank
13	*Axonopus compressus*	Dolicha-bon	Through seeds, root suckers	Good forage value, low fertility soils, particularly in shaded situations
14	*Axonopus affinis*		Through seeds, root suckers	Good forage value, low fertility soils, particularly in shaded situations

D. Species wise details of Shrubs and Bamboo indicating planting methods and their usages

S.No.	Species	Local Name	Planting method	Planting Time	Specific features
1	*Abelmoschus moschatus*	Gorokhiua-koroi	Through seeds	In rainy season	Medicinal property , well drained acidic soil
2	*Abroma augusta*	Hati-piola	Through seeds,cuttings	In rainy season	Medicinal property, Grow when soil condition is not favorable of less fertile.
3	*Ardisia humilis*	Chaul-dhuwa /Tolotha- paka	Through seeds,cuttings	In rainy season	Medicinal property, Prefer wet soil.
4	*Ardisia solanacea*	Chaul -dhuwa	Through seeds,cuttings	In rainy season	Medicinal property, Prefer wet soil.
5	*Calamus erectus*	Bent	Through seeds,cuttings	In rainy season	Medicinal property, Prefer wet soil.
6	*Clerodendrum glandulosum*		Through seeds	In rainy season	Medicinal property
7	*Clerodendrum serratum*		Through seeds	In rainy season	Medicinal property
8	*Croton caudatus*		Through seeds	In rainy season	Medicinal property, Prefer wet soil
9	*Croton oblongifolius*		Through seeds, cuttings	In rainy season	Medicinal property, Prefer wet soil
10	*Glochidion multiloculare*		Through seeds	In rainy season	Medicinal property, Prefer wet soil
11	*Litsea salicifolia*		Through seeds	In rainy season	Medicinal property, Prefer wet soil
12	*Melastoma malabathricum*	Key Sengs	Through seeds, Cuttings, rootshoot cutting	In rainy season	Medicinal property, Prefer wet soil
13	*Morinda angustifolia*		Through seeds	In rainy season	Medicinal property, Prefer wet soil
14	*Mussaenda frondosa*	Tengmeng	Through seeds, cuttings	In any season	Medicinal property, Prefer wet soil
15	*Mussaenda roxburghii*	Tengmeng	Through seeds, cuttings	In any season	Medicinal property, Prefer wet soil
16	*Saurauia napaulensis*		Through seeds	In rainy season	
17	*Solanum torvum*		Through seeds	In rainy season	Medicinal property
18	*Zanthoxylum acanthopodium*	Yokhung	Through seeds, cuttings	In any season	Medicinal property, Prefer wet soil
19	*Bambusa pallida*	Makal	Through seeds,cuttings, rootshoot cutting	Aug.-Sept.	
20	*Bambusa tulda*	Shingane Bans	Through seeds,cuttings, rootshoot cutting	In any season	

ANNEXURE X

Names and dates of visits of consultants and experts

SN	Dates	Place
1	26.10.2015 to 30.10.2015	Adjoining areas of NEC study side, Margherita.
2	24.11.2015 to 29.11.2015	Saleki PRF, Lekhapani RF, and Tipong RF along with the adjoining areas.
3	30.11.2015 to 4.12.2015	Tinkupani RF and Dalai PRF.
4	05.01.2016 to 09.01.2016	Tinkupani RF and Tipong RF.
5	18.01.2016 to 23.01.2016	Saleki PRF, Upper Dihing RF, Lekhapani RF and adjoining areas.
6	27.01.2016 to 03.02.2016	Lekhapani RF, Saleki PRF, Namphai RF, Kotha RF and Saleki PRF.
7	22.02.2016 to 28.02.2016	Upper Dihing RF, Dirak RF and Tipong RF.
8	01.03.2016 to 11.03.2016	Tipong RF and Tinkupani RF.
9	15.03.2016 to 20.03.2016	Tipong RF and Tinkupani RF.
10	06.06.2016 to 10.06.2016	Tipong PRF and Lekhapani RF
11	04.07.2016 to 08.07.2016	Dirak RF, Kotha RF, Lekhapani RF, Saleki PRF, Tirap RF, Tipong RF, Tipong PRF and Tinkupani RF
12	18.07.2016 to 22.07.2016	Kotha RF, Upper Dihing RF, Saleki PRF and Lekhapani RF.
13	16.07.2016 to 22.07.2016	Dalai PRF, Dirak RF, Kotha RF, Lekhapani, Saleki PRF, Tipong PRF, Tipong RF and Tinkupani RF.
14	23.07.2016 to 26.07.2016	Tirap RF, Tinkupani RF and Saleki PRF
15	26.07.2016 to 30.07.2016	Tipong RF, Tipong PRF and Saleki PRF
16	01.08.2016 to 06.08.2016	Lekhapani RF, Tipong PRF and Tirap RF
17	18.08.2016 to 23.08.2016	Tipong RF , Tirap RF and Lekhapani RF
18	22.08.2016 to 26.08.2016	Tipong PRF and Dirak RF.
19	29.08.2016 to 08.09.2016	Tirap RF, Saleki PRF, Lekhapani RF, Tipong RF, Tinkupani RF, Dirak RF and adjoining areas
20	20.09.2016 to 24.09.2016	Dalai RF, and Tirap RF.
21	24.09.2016 to 05.10.2016	Tirap RF, Tinkupani RF, Upper Dihing RF, Kotha RF, Lekhapani RF, Saleki PRF, Tipong RF, Tirap RF, and Tipong PRF.
22	3.10.2016 to 10.10 2016	Tinkupani RF, Saleki PRF, Lekhapani RF, Tipong RF and Namphai RF.
23	24.10 2016 to 28.10 .2016	Dirak RF, Tirap RF and Lekhapani RF.
24	07.11.2016 to 11.11.2016	Tirap RF, Lekhapani RF, Saleki PRF and Tipong RF.
25	07.11.2016 to 17.11.2016	Upper Dihing RF, Lekhapani RF and Dirak RF.
26	19.12.2016 to 22.12.2016	Tirap RF and nearby areas

Besides, surveys for faunal studies were done continuously for three months from mid July to mid October, 2016.

ANNEXURE XI

PROCEEDINGS

of the workshop cum consultative meeting on

Biodiversity Management Plan and Regional Wildlife Plan for Makum Coalfields, Assam

Venue: Conference Hall, Margherita Block Development office, Margherita, Tinsukia, Assam

Dated: 15 March 2017

Organized by

RAIN FOREST RESEARCH INSTITUTE

Indian Council of Forestry Research & Education

(An Autonomous body of Ministry of Environment, Forests & Climate Change, Govt. of India)

Post Box No. 136, Jorhat- 785001, Assam

A workshop cum consultative meeting on **"Biodiversity Management plan and regional wildlife plan for Makum coal fields, Assam"** was organized by **Rain Forest Research Institute, Jorhat** at Conference Hall of Block Development Office, Margherita Block, Tinsukia District on 15 March 2017. The prime objective of the workshop was to present the findings of the study conducted by the Rain Forest Research Institute, Jorhat under the project entitled "Preparation of Biodiversity Management Plan, Regional Wild life Plan and Carrying capacity Study for the Makum Coal fields in Assam" funded by North Eastern Coalfields (NEC), Coal India Ltd for the Assam Forest Department. The objective also included discussion and enlisting the suggestions/comments of the participants for further improvement of the Biodiversity Management Plan, Regional Wildlife Plan and Carrying Capacity Study for Makum Coalfields, Assam. All the stakeholders including representatives from District administration, Forest department, elected representatives, local Gaon Panchayats and subject matter experts were invited to discuss the findings and chalk out appropriate mitigative measures in the light of the findings of the study done by RFRI, Jorhat.

A. Participants of the workshop

1. Shri Bikram Kairi, IAS, SDO (C), Margherita
2. Shri M.K. Dhar, DFO (WL), Tinsukia Wildlife Division
3. Shri Ram Chandra Deori, BDO, Margherita
4. Mrs. Gitanjali Sonowal, President, Block Panchayat, Margherita
5. Dr. Dilip Chetry, Vice President, Aranyak, Guwahati
6. Dr. Rajib Rudra Tariang, Assistant Professor, Digboi College, Digboi
7. Dr. Saroj K. Swain, Principal Scientist, ICAR-CIFA, Bhubaneswar, Odisha
8. Dr. Runa Bhagabati, Assistant Professor, Margherita College, Margherita
9. Shri N. N. Deka, ACF, Digboi Forest Division
10. Shri Indranil Ray, NEC, Margherita
11. Shri Mridu Paban Phukan, Rainforest Conservation Education Centre, Naharkatia
12. Dr. Ranjita Bania, Jeeva Suraksha (NGO), Sibsagar
13. Shri Romesh Hatimuria, Sanjivani – North East Socioeconomic Welfare Society
14. Shri Pabita Borgohain, Sanjivani – North East Socioeconomic Welfare Society
15. Shri Lek Bahadur Chetry, S.A. PWD Rural Road Sub-Division, Margherita
16. Shri Dhurba Dutta, Forest Range Officer, Margherita East Forest Range
17. Shri Dhimanshu Saikia, Forest Range Officer, Margherita West Forest Range
18. Shri Padum B.P. Guhain, Forest Range Officer, Jagun Forest Range
19. Shri Khargeshwar Konwar, Deputy Range Officer, Margherita East Forest Range

20. Shri Bidyadhar Sonowal, Forester, Lekhapani Forest Range
21. Ms. Kanika Dey, President, Ledo Gram Panchayat
22. Shri Keshab Acharjee, President, Ledo Colliery Gram Panchayat
23. Shri Sukhdeb Sharma, Samukjan Gram Panchayat
24. Shri Ranjit Hazarika, President, Samukjan Gram Panchayat
25. Shri Raktim Khound, President, Bargoloi Gram Panchayat
26. Shri Ishwar Prasad Sharma, Secretary, Lekhapani Gram Panchayat
27. Ms. Sangita Deori, President, Jagun Gram Panchayat
28. Shri Bhupen Pegu, Ward member, Jagun Gram Panchayat

B. Participants from Rain Forest Research Institute, Jorhat

1. Dr. Dhruba Jyoti Das, Scientist, RFRI, Jorhat
2. Shri Ajay Kumar, Scientist, RFRI, Jorhat
3. Shri Protul Hazarika, Research Assistant, RFRI, Jorhat
4. Dr. Girish Gogoi, Research Assistant, RFRI, Jorhat
5. Shri Abhijit Medhi, Technical Assistant, RFRI, Jorhat
6. Shri Abhinab Bora, Project Assistant, RFRI, Jorhat

Minutes of the meeting

The workshop cum consultative meeting was opened with a formal speech by Dr. Dhruba Jyoti Das, Scientist D, RFRI welcoming the participants. This was followed by introduction of the participants that included a brief about the area of interest of the participants. Shri Bikram Kairi, SDO (C), Margherita chaired the session. A detailed Power Point presentation on the findings and the possible management measures proposed by RFRI under Biodiversity Management Plan and Regional Wildlife Plan was made by Dr. Dhruba Jyoti Das, Scientist D. The presentation was followed by a vibrant group discussion where all the participants were requested to give their comments and suggestions for further improvement of the management plans.

Shri Bikram Kairi, Sub-Divisional Officer (Civil) informed the house that there were a lot of complaints from the villagers regarding the contamination and pollution of the water bodies owing to the mine discharge and suggested that NEC should take proper measures to address the issue. He suggested that comparative information based on time-series data of forest degradation may be incorporated in the present study. Shri Kairi stated that illegal felling is a serious issue in the region, carried out by means of axes and chain saws. He also questioned the functionality of the butterfly and orchid park established by the NEC Ltd. at Ledo and called for improvement. Shri Kairi emphasised on the lack of awareness among the local communities about the invasive

plant species, considering these plants to be a part of the forest and therefore do not understand their ecological consequences. Communities should be thus sensitized through a series of awareness programmes.

Shri N. N. Deka, Assistant Conservator of Forests, Digboi Forest Division insisted on proper reclamation of the existing and closed mining sites before proceeding for further mining activities. He underlined the importance of a time bound mitigative plan to counter the destruction caused by open cast mining projects and opined that the agency implementing the management plan should be specific and different work should be implemented by separate agencies/departments. Execution plan with budget, locations, drawing and design of interventions like check dams, greenbelt, plantations, etc and location of fragmentations should be included. Specific location wise plan including provision for creation of nursery to improve the present status of the forest, control measures for pollution of water resources should be included. A specific plan for community development including eco-tourism may also be included in biodiversity management plan. He insisted to add a provision for a requisite number of contractual trained forest staff for the project period towards the implementation of the biodiversity management plan and regional wildlife plan. He also suggested proper top soil management of the mining and dumping areas.

Dr. Dilip Chetry, Executive Director, Gibbon Conservation Centre (Aranyak) said that there should be specific agencies to execute the different parts of the management plans. He further emphasized on the necessity for division of responsibilities among various agencies for proper implementation of the management plan. Dr. Chetry pointed out lack of sufficient knowledge on the endemic flora and fauna, especially on Primates in the report and suggested inclusion of the relevant data from secondary sources. He further made a number of suggestions- yearly monitoring of pollution (Air, Water, Noise, etc.), planting of specific tree species such as the *Ficus* which is important for the feeding and lodging of Gibbons, inclusion of a proper monitoring plan regarding the participation of local communities, experts, forest officials and NGOs, organization of workshop/meeting in each Panchayat for collection of views of the local people about the management plan, preparation of a eradication plan for the invasive species keeping in mind that these species have become the food source of a number of animals and translocation of the Gibbons from the project area to a better and large habitat area.

Dr. Rajib Rudra Tariang, Assistant Professor at Digboi College pointed out, the non implementation of the topsoil management plan included in the previous NEC mining plan and that the old plan should be carried out before the reforms mentioned in the

new management plan are bought into action. He insisted on calling an urgent meeting of all the stakeholders to take stock of the status of the earlier management plans of NEC. Dr. Tariang complained about the contamination of the drinking water source in the mining region, non implementation of scientific blasting process in the coal mine leading to negative impact on the wildlife especially on the Western Hoolock Gibbon, non functioning of the NEC effluent treatment plant and demanded immediate steps be taken for running the same. He also informed about the research work of some of the faculty members of local colleges in and around Makum Coal field area regarding restoration of indigenous biodiversity through suitable plantation on restored sites of open cast coal mining areas in Margherita region.

Shri M.K. Dhar, DFO, Tinsukia Wildlife Division, Tinsukia also emphasized on the restoration of the existing and closed mining areas before proceeding for further mining activities. Shri Dhar suggested that a short survey of the project area should be carried out to enumerate the demographic details of the area and of the people affected by the project to learn about the existing management scenario of the area. Participatory Rural Appraisal (PRA) exercise may also be conducted to record the community perception for the biodiversity and wildlife management in the forest fringe areas.

Dr. Runa Bhagabati, Assistant Professor of Margherita College praised the initiative taken up by RFRI to conduct the workshop and to prepare a biodiversity database of the area surrounding the Makum Coalfields. She made many important suggestions to further improve the management plan, inclusion of a proper monitoring plan at ecological, hydro biological level, assessment of the current status of the hydro biology, wildlife and socio biology, analysis of Acid Mine drainage and preparation of mitigation plans for treating the same, development of a plan for alternative income source with the inclusion of eco tourism. Dr. Bhagabati expressed an interest to be an active partner of the project with reference to "Wetland Management" in and around Makum Coalfield area.

Shri Romesh Hatimuria of Sanjeevani, North East Socio-Economic Welfare Society, an NGO in Margherita emphasized on the management and proper maintenance of topsoil in the mining area. Mr. Hatimuria pointed out the non implementation of plantation and restoration work in the existing and closed mining areas. He emphasized on the poor mine drainage and non functionality of the Effluent Treatment plant of NEC which is polluting the river system of the area. The suggestions made by Mr. Hatimuria included – assessment of toxic gases released by open cast mines,

incorporation of mitigation measures for the toxic gases in the plan and inclusion of biodiversity outside the Forests in the management plan.

Mrs. Gitanjali Sonowal, President of Block Panchayat in Margherita emphasized on the necessity of protection of the plants and wild animals in and around mining area and enquired regarding the implementation and monitoring agency of the management plan which was not mentioned in the presentation. She suggested some reforms viz., inclusion of provisions of alternate energy sources for the local communities to reduce the illegal feeling and lopping of forests, furnishing of compensation to the farmers whose agriculture land got contaminated by mine discharge, discussion regarding the impact of previous open cast mining by NEC on land, water and air. Mrs. Sonowal enquired after the mitigation steps taken by NEC to curb the impacts of open cast mining. Shri Mridu Paban Phukan of Rainforest Conservation Education Centre in Naharkatia pointed out that the bird species Beautiful Sibia (*Heterophasia pulchella)* is not present in the study area as mentioned in the report. The suggestions forwarded by him are- conduction of a perception survey regarding the implementation of management plan and inclusion of the results in the final management plan, inclusion of the current condition of the existing OB dumps and mine drainage/ discharge with their management strategies in the plan, development of Ecotourism in Tirap and Tikak with proper reclamation of the mining areas.

Dr. Ranjita Bania of Jeeva Suraksha, an NGO in Sibasagar emphasized on developing community oriented strategies for biodiversity and wildlife management in the Makum coalfield area by encouraging PRA activities in each Gram Panchayat. She forwarded a number of suggestions viz., a time bound biodiversity management plan, specification of follow up period for NEC authorities after the completion of management plan period, provision for regular motivation and awareness programme for the local communities regarding the biodiversity, wildlife and invasive species. Dr. Bania also emphasized on the importance of aquaculture as a possible means of alternative income source for the locals.

Shri Sukhdeb Sharma, President of Samukjan Gram Panchayat opined about the improper execution of the CSR plan by NEC and the resulting grievances of the local communities. He complained about the ground water contamination caused by mining activities and the scarcity of pure drinking water as a result. He also emphasized on the consequences of mine discharge accompanied by highly acidic soil and coal dust which has rendered nearby paddy fields uncultivable. Since, NEC has not addressed the said issues he wanted the inclusion of these activities with necessary management plan in the report. Shri Keshab Acharjee, President of Ledo Colliery Gram Panchayat informed

about the organization of two number of Gram Sabha meetings in the office of Ledo Colliery Gram Panchayat a few days ago and three meetings were also organized in the presence of NEC officials at the behest of Deputy Commissioner. Matters related to the CSR of NEC were discussed in these meetings. He expressed his concern about the declining diversity and density of fish in the rivers of the area due to water pollution caused by mine discharge and pointed out the lack of community development work by the NEC. Shri Ishwar Prasad Sharma, Secretary of Lekhapani Gram Panchayat insisted on the formulation of a specific plan for the conservation of habitat of Hoolock Gibbon in the region and suggested that NEC should take necessary steps to save the biodiversity of the area including human beings. Ms. Kanika Dey, President of Ledo Gram Panchayat conveyed that her GP has a lot of grievances towards NEC and requested the RFRI team to hold a discussion with the local people.

Shri Dhimanshu Saikia, Forest Range Officer of Margherita West Forest Range suggested that the eradication of invasive species should be carried out keeping in mind about food habit of wildlife and emphasized that poisoning of the water bodies should be controlled. Shri Padum B.P. Gohain, Forest Range Officer of Jagun Forest Range suggested that the management plan should be community oriented and should emphasize on habitat conservation. He stated the workshop to be a fruitful one and that the comments of the participants will help in preparation of the plan. Shri Bidyadhar Sonowal, Forester of Lekhapani Forest Range suggested that people from grass root level of the local communities along with the officials from forest department should be encouraged to participate in the workshop. He further said that meetings should be organized with the coal affected people in the various Gram Panchayats and that NEC officials should have also participated in the workshop.

Other participants also put forward similar comments and it was unanimously stated that, there is contamination of the water sources in the area due to various mining activities and improper mine drainage and that there is a lack of specific Mitigative measure for the treatment of mine drainage/discharge. Every participant showed his/her concern towards the conservation of habitat of wildlife, especially Gibbon.

The workshop was concluded with a vote of thanks given by Ajay Kumar, Scientist, RFRI.

Glimpses of the workshop

A view of the workshop

Shri Bikram Kairi expressing his views

Dr. Dilip Chetry expressing his views

Dr. Rajib R. Tariang expressing his views

Gitanjali Sonowal, M.K. Dhar and N. N. Deka

Shri Ram Chandra Deori and Dr. R. Bhagawati

A view of the vibrant discussion

Group Photo-1

PHOTOGRAPHS

- **Signature of Agreement, 16 September 2015:**


- **Reconnaissance survey of the study site:**



Landscapes

Photo 1:
Landscape -Tirap Reserve Forest

Photo 2:
Landscape - Shifting Cultivation

Photo 3:
Landscape -Mining Sites

Photo 4:
Landscape -Tea garden

Fauna

Photo 5:
Indian crested porcupine *(Hystrix indica)*

Photo 6:
Asian palm civet *(Paradoxurus hermaphroditus)*

Photo 7:
Indian Muntjac
(Muntiacus muntjak)

Photo 8:
Indian Muntjac
(Muntiacusmuntjak)

Photo 9:
Indian Muntjac♂*(Muntiacus muntjak)*

Photo 10:
Indian Muntjac
(Muntiacus muntjak)

Photo 11:
Western Hoolock Gibbon♂*(Hoolock hoolock)*

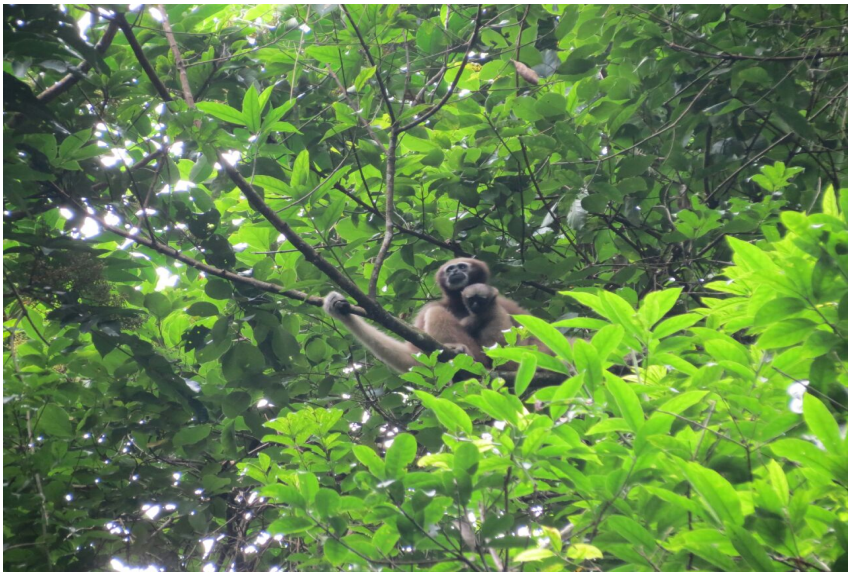


Photo 12:
Western Hoolock Gibbon♀*(Hoolock hoolock)*

Photo 13: Domesticate Asian elephant *(Elephas maximus)*

Photo 14: Asian elephant dung pile *(Elephas maximus)*

Photo 15: Probable Pugmark of Clouded Leopard *(Neofelis nebulosa)*

Photo 16:
Probable Pugmark of Clouded Leopard *(Neofelis nebulosa)*

Photo 17:
Probable scat of Indian leopard *(Panthera pardusfusca)*

Photo 18:
Red headed trogon female (Harpactes erythrocephalus)

Photo 19:
Elephant foot mark

Field work

Photo 20:
Camera trapping

Photo 21:
GPS recording

Photo 22:
Marking the trees

- **Major Land uses/ covers: Forests**



- **Major Land uses/ covers: Bamboo brakes**


- **Major Land uses/ covers: Agriculture**


- **Major Land uses/ covers: Tea garden**


- **Major Land uses/ covers: Plantation Scrub land**


- **Major Land uses/ covers:**
  Settlement Water body



- **Ground Vegetation**



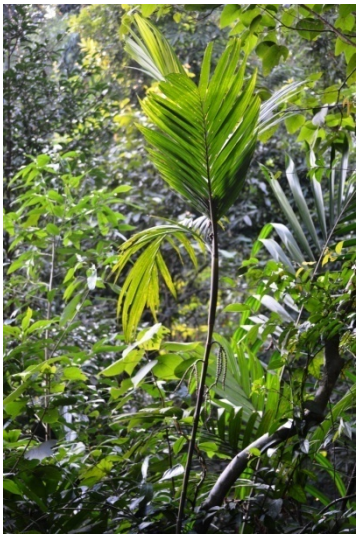

- **Disturbances**








- **Few Important tree species**



Arenga gracilis

Canna sp

Castanopsis indica

Cyathea sp

Dioscoria spp

Dipterocarpus retusus

Calicarpa arborea

Delima indica

1. Aerides odorata

2. Dendrobium aphyllum

3. Dendrobium lituiflorum

4. Malaxis latifolia

5. *Luisia zylanica*

Photographs showing various orchid species (1-5)

1. Great Myna, *Acridotheris grandis*

2. Eurasian Tree Sparrow, *Passer montanus*

3. Green-billed Malkoha,*Rhopodytes tristis*

4. Lesser Racket-tailed Drongo, *Dicrurus remifer*

5. Drongo Cuckoo, *Surniculus lugubris*

6.Bronzed Drongo,*Dicrurus aeneus*

7. Long-tailed Broadbill, *Psarisomus dalhousiae*

8. Common Tailorbird,*Orthotomus sutorius*

9. Red breasted parakeet,*Psittacula alexandri*

10. Yellow-footed Green Pigeon, *Treron phoencopterus*

11. Chestnut-bellied Nuthatch, *Sitta castanea*

12. Large Woodshrike, *Tephrodornis virgatus* (male)

13. Pin-striped Titbabbler, *Macronus gularis*

14. Rufous Woodpecker,*Micropternus brachyurus*

15. Blue-throated Barbet, *Megaliama asiatica*

16. Long-tailed Minivet, *Pericrocotus ethologus*

Various birds species found in the study area (1-16)

Family: Hesperiidae

1.Northern Spotted Ace, *Thoressa cerata*

2. Light Straw Ace,*Pithauria stramineipennis*

3. Coon, *Psolos fuligo subfasciatus*

4. Restricted Demon, *Notocrypta curvifascia*

5. Rice Swift, *Borbo cinnara*

6. Chestnut Bob,*Lambrix salsala*

7. BushHopper, *Ampittia dioscorides*

8. Indian Awlking, *Choaspes benjaminii*

9. Yellow Flat, *Mooreana trichoneura*

10. Extra Forest Bob, *Scobura cephala*

11. Dark Velvet Bob, *Koruthaialos butleri*

12.Fulvous Piedflat*, Pseudocoladenia dan*

Family: Lycaenidae

13. Chocolate Royal, *Remelana jangala*

14. Punchinello, *Zemeros flegyas*

15. Banded Lineblue, *Prosotas aluta coelestis*

16. Royal Cerulean, *Jamides caeruleus*

17. Fluffy Tit, *Zeltus amasa*

18. Bright Sunbeam, *Curetis bulis*

19. Common Hedge Blue, ***Acytolepis puspa***

20. Elbowed Pierrot, ***Caleta elna***

21. Purple Sapphire, *Heliphorus epicles*

22. Branded Yamfly,*Yasoda tripunctata*

23. Common Yamfly, ***Loxura atymnus***

24. Long-banded Silverline, ***Spindasis lohita***

Family:Nymphalidae

25. Plain Bushbrown, *Telinga malsarida*

26. Dark Catseye, *Zipaetis scylax*

27. Straight Banded Treebrown, *Lethe verma*

28. Common Bushbrown, *Mycalesis perseus*

29. Red Tailed Forester,*Lethe sinorix*

30. Common Fivering, *Ypthima baldus*

31. Tawny Rajah, *Charaxes bernardus*

32. Tawny Rajah, *Charaxes bernardus*

33. Yellow Rajah, *Charaxes marmax*

34. Unbroken Sergeant, *Athyma pravara*

35. Common Nawab,*Polyura athamas*

36. Knight, *Lebadea martha*

37. Leopard Lacewing, *Cethosia cyane*

38. Striped Tiger, *Danaus genutia*

39. Wizard, *Rhinopalpa polynice*

40. Dark Archduke, *Lexias dirtea khasiana*

41. Common Jester, *Symbrenthia lilaea*

42. Grey Count, *Tanaecia lepidea*

43. Yellow Sailer, *Neptis ananta*

44. Common Maplet, *Chersonesia risa*

45. White-edged Blue Baron, *Euthalia phemius*

46. Powdered Baron, *Euthalia monina*

47. Commander, *Moduza procris*

48. Staff Sergeant, *Athyma selenophora*

Family: Pieridae

49. Red Base Jezebel, *Delias pasithoe*

50.Tailed Sulphur, *Dercas verhuelli*

51. Chocolate Albatross, *Appias lyncida* (female)

52. Common Grass Yellow, *Eurema hecabe*

53. Common Tree Yellow, *Gandaca harina*

54.Chocolate Albatross, *Appias lyncida*

Family: Papilionidae

55. Tailed Jay, *Graphium Agamemnon*

56. Common Peacock, Palipio paris

57. Great Jay, Graphium eurypylus

58. Golden Birdwing, *Troides aeacus*

59. Yellow Helen, *Papilio nephelus*

60. Five Bar Swordtail, *Graphium antiphates*

Photographs: Insects

Unknown Spider

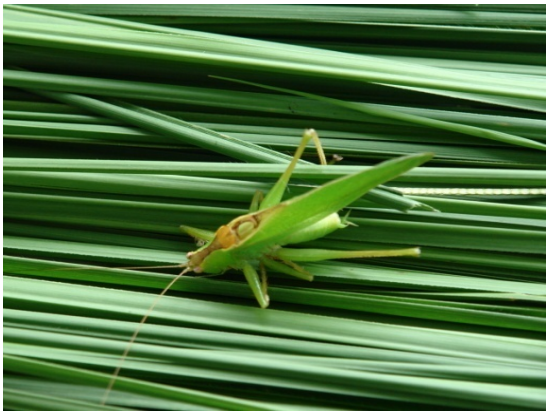
Phlaeoba pictus

Praying mantis

Phlaeoba pictus

Trigonocoryapha unicolor

Busy at field



Heiroglyphus banian

Dragon Fly

Anax Sp.(Dragon fly)

Catantop sp.

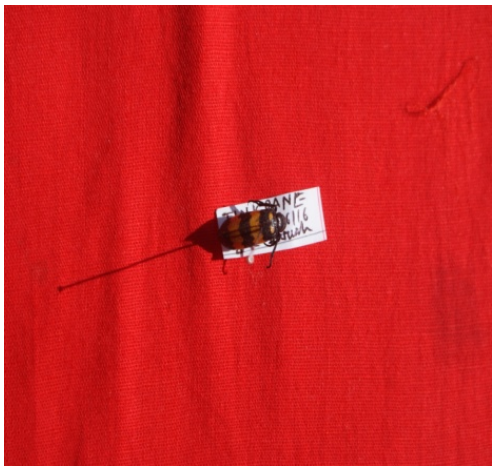
Unknown caterpillar

Unknown caterpiller

***Diabolocatantops pinguis* (Walker).**

Phlaeoba infumata

Oxya nitidula



Mylabris pustulata