WILDLIFE CONSERVATION PLAN FOR THE IMPACT ZONE OF ETALIN HEP

DIBANG VALLEY DISTRICT,
ARUNACHAL PRADESH

Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh

भारतीय वन्यजीव संस्थान
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Abbreviations

AP: Arunachal Pradesh

ArcGIS: Aeronautical Reconnaissance Coverage Geographic Information System

BRO: Border Roads Organization

BV_j: Biodiversity value in a sampled grid j

CCO: Camps, colony and Offices

CR: Critically Endangered

CS: Conservation status

CSR: Corporate Social Responsibility

CT: Camera Trap

DD: Data deficient

DEM: Digital Elevation Model

DO: Dissolved Oxygen

DR: Dri River Limb

DS: Dam Site

DiS: Direct Sightings

DSA: Dam Submergence Area

DWLS: Dibang Wildlife Sanctuary

DY: Dumping Yard

EC: Electrical conductivity

EHEP: Etalin Hydro Electric Power Project

EHEPCL: Etalin Hydro Electric Power Company Limited

EIA: Environmental Impact Assessment

EI_j: Exclusive impact in a sampled grid

EMP: Eenvioronment Management Plan

ERDAS: Earth Resource Development Assessment System

FAC: Forest Advisory Committee

FCA: Forest Conservation Act

FG: Foraging Guild

FRL: Full Reservoir Level

GBH: Girth at Breast Height

GIS & RS: Geographic Information System and Remote Sensing

Gn: Genera

GOI: Government of India

GPS: Global Positioning System

H': Shannon Diversity Index

H-al: High Altitude forests

HEP: Hydro Electric Project

HEPP: Etalin Hydroelectric Power Project

HRT: Head race tunnel

IBA: Important Bird Areas

IHR: Indian Himalayan Region

IP_j: Impact potential

IR: Infrared

IUCN: International Union for Conservation of Nature and Natural Resources

IVI: Importance Value Index

IWPA: Indian Wildlife Protection Act

KBA: Key Biodiversity Areas

LC: Least Concern

LULC: Land Use and Land Cover

MoEF&CC: Ministry of Environment, Forest and Climate Change

MS: Migratory Status

MSAVI-2: Modified Soil Adjusted Vegetation Index 2

MW: Mega Watt

MWLS: Mehao Wildlife Sanctuary

NEHU: North Eastern Hill University

NIZ: Non-impact zones

NMDS : Non-metric multi-dimensional scaling

Nt: Near Threatened

NTFP: Non-Timber Forest Products

O-PA: Outside Project Area

P/S Cavity Nesters: Primary / Secondary Cavity Nesters

PA: Project Area

PAFs: Project Affected Families

PAP: Project Affected People

PAVs: Project Affected Villages

PH&C: Power House and Confluence

PU: Polyurethane

PVI: Prominence value index

QS: Quarry Site

R&R: Resettlement & Rehabilitation

RAI: Relative Abundance Index

RET: Rare, Endangered and other Threatened species

SANDRP: South Asia Network on Dams, Rivers and People

SAT: Study area total

SC: Specific Conductivity

Sch I: Schedule I

Sch-IV: Schedule IV

SCS: Species of Conservation Significance

SD: Standard Deviation

Sp: Species

SV: Summer Visitor

TBA: total basal area

TRL : Tangon River Limb

TR : Tiger Reserve

TRT : Tail race tunnel

VES: Visual Encounter Survey

VU: Vulnerable

W/B: Workshops, Stores and Batching Plants

WII: Wildlife Institute of India

WM-L al: Winter migrant to Lower altitude

WQ: Water quality parameters

WV: Winter Visitor

ZoI: Zone of influence

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All of Idu Mishmi people in Dibang Valley and Lower Dibang Valley

Prayeeba (Thank you)

Executive Summary

Background

The Etalin Hydro Electric Power Company Limited (EHEPCL) has proposed to develop 3097 MW Etalin Hydroelectric Power Project (HEPP) in Dibang Valley district of Arunachal Pradesh. This run-of-the-river project envisages utilization of waters of Dri and Tangon (also known as Talo) rivers for hydropower generation. The water diversion structure on Dri limb is located near Eron village which is about 22 km from Etalin village and the water diversion structure on Tangon limb is located near Anonpani village which is about 17 km from Etalin village. The powerhouse site is located near the confluence of these two rivers near Etalin village, where the river takes the name Dibang. A 101.5 m and 80 m high concrete gravity dams will be built in Dri and Tangon limbs with a total area of submergence 83.22ha and 36.12 ha, respectively. A total of 1,155.11 ha of land is required which would be acquired for construction of project components, submergence area, muck dumping, quarrying, construction camps and colony, etc. The total submergence area due to the dams will be 119.44 ha. A total of 18 villages consisting of 285 families will be affected by the proposed project. The estimated cost of the project is Rs. 25,296.95 crores and it is proposed to be completed in 7 years.

In accordance with the recommendations of "Forest Advisory Committee" (FAC), MoEF & CC and letter no. FOR-279/CONS/2010/Vol-I/836-40 dated 23rd June, 2017 from APCCF & Nodal Officer (FCA), Arunachal Pradesh to Director, Wildlife Institute of India, Dehradun (Annexure-I), a multiple seasonal replicate study to prepare and submit wildlife and biodiversity plan is required to be conducted. The primary scope of the WII study was to prepare biodiversity profile of the study area both through field survey as well as through review of published literature and suggest measures for species conservation and management.

In response to this directive, the Wildlife Institute of India submitted a technical proposal to the Department of Environment and Forest, Government of Arunachal Pradesh, for undertaking the desired study. The primary objectives of the study are:

a. To determine the current status of wildlife habitat and distribution pattern of plants, entomofauna, fish, herpetofauna, birds and mammals within the impact zone of the Etalin hydroelectric project (EHEP) area covering multiple seasons.
b. Status and distribution pattern of certain 'Rare, Endangered and other Threatened (RET) species in the impact zone of the EHEP.
c. Identification of critical habitats, wildlife corridors and migratory paths of RET species in the impact zone.
d. Assessment of the likely impacts due to the construction and operation of the EHEP and associated activities on flora, fauna and their habitats.
e. Develop a Wildlife Conservation Plan in order to avoid/mitigate likely hydropower impacts and conserve key biodiversity areas and species.

Based on the objectives of the study, an elaborate scope of work was developed to generate information relevant for developing information and knowledge base with reference to the different biological components included within the purview of consideration for this study.

The EHEP (3,097 MW) is a run-of-the-river project which envisages constructing two concrete gravity dams namely (i) a 101.5 m high dam on the Dri river near Yuron village about 22 km from Etalin and (ii) a 80 m high dam on the Tangon river about 800 m downstream of Anon Pani confluence with Tangon river (from the deepest foundation). The water will be diverted via two separate waterway systems to utilize the available head in a common underground powerhouse located just upstream of the confluence of the two rivers. The underground powerhouse is proposed with 10 units of 307 MW each. In order to utilize the releases of flow for sustenance of aquatic life, a dam - toe powerhouse with 19.62 MW capacity on Dri diversion and dam-toe powerhouse with 7.40 MW capacity on Tangon diversion have been proposed.

Methods

The impacts due to hydropower development on terrestrial and, particularly, aquatic ecology is spatially and temporally extensive and typically broader than the immediate project area. Given the rapid nature of the study, the study area boundaries were defined by the delineation of the Zone of Influence (ZoI) of the EHEP. The Zone of Influence is defined as the farthest possible distance of influence of the development project, emanating from various impact sources. Identification of impact sources took into consideration of type of activities, location and extent of (a) Dam, (b) Submergence, (c) Headrace tunnel, (d)Tailrace tunnel, (e) Muck disposal areas, and (f) Built-up areas for establishing various infrastructures including road network.

The Institute's multidisciplinary team undertook surveys within the Zone of Influence (ZoI) of EHEP, particularly focusing on the immediate impact areas/zones of the hydropower and associated activities e.g., muck disposal sites, quarry areas and other land-acquisition areas. Information on different terrestrial and aquatic biodiversity components was gathered. As hydroelectric projects have a direct bearing on the habitats of both terrestrial and aquatic species, specific taxa were targeted for conducting impact assessment. Taxonomic groups that have flagship values and keystone effects, and are highly sensitive to changes in the habitat and intensity of disturbance in their habitats were selected for the assessment. In this study, mammals, birds, entomofauna, herpetofauna and plants were considered to represent the terrestrial system and fishes and benthic invertebrates were included to represent the aquatic system. The field surveys were conducted between February and May/June 2018, with sampling replicates covering multiple seasons namely, winter / pre-monsoon (February-March), summer / monsoon (April-June).

Terrestrial biodiversity:

Flora: The flora within the ZoI of the Etalin HEP were surveyed in order to generate baseline information and to identify key plant biodiversity areas and key plant species (RET, endemic species) using reconnaissance survey followed by quadrat sampling.

A total of 15 sites were selected randomly depending on accessibility and approach within the ZoI that include the land acquisition sites along both the Dri and Tangon rivers. Within these 15 plotsoverall, 133 plots for trees and shrubs and 266 plots for herbs were quantified. Project land use specific distribution of number of plots sampled

Entomofauna: A total of 63 transects for spiders and 65 transects for butterflies and dragonflies were walked, covering a total distance of 128 km. In addition, forest trails (cumulative distances of 16km) were surveyed for both spiders and butterflies.

Herpetofauna: The abundance of amphibians was assessed using Visual Encounter Survey (VES; Steinke, 2016), along the roads and streams. Frog calls were also used to record the species (Allison and Englund, 2005). Time Constrained Search method (Welsh, 1987) was also followed wherein a specific micro habitat was searched intensively for 5-10 min depending on the size of the microhabitat. Additionally, other opportunistic sightings were also recorded

Avifauna: A total of 89 variable radius point count plots were surveyed and total distance of 50.5 km was covered via line transects. Overall, using McKinnon's species richness method (McKinnon and Philip, 1993), 49 lists were enlisted.

Mammals: A total of 78 camera traps were deployed over an area of 53 km^2 and a total of 1552 trap nights were sampled in the post monsoon/winter and pre-monsoon season. All the species photo captured in the camera were listed.

Aquatic biodiversity:

Assessment of water quality parameters: The physico-chemical variables, namely dissolved oxygen (mg/l), pH, water temperature (^{0}C), specific conductance (µS/cm), total dissolved solid (ppm), electrical conductivity (µS/cm), were measured at each of the sampling segments using YSI water quality kit (YSI, Proportional Plus, USA)

Habitat Assessment: As a part of habitat assessment, certain key river meso-habitat characteristics, i.e. runs, riffles, pools and cascades, were measured in all 35 sampling sites. A sampling segment consist of approximately 100-150 m in length. All-important river characteristics were measured in each segment.

Fish Sampling- Fish sampling was done using different types of fishing gears such as cast net, gill net with different mesh size (0.5 × 0.5 mm, 1 cm × 1 cm, 1.5 cm × 1.5 cm), and employing local method (bamboo traps, etc). Fish sampling was done for approximately 60 minutes in each stream segment.

Benthic invertebrates sampling- Benthic invertebrate sampling was done using drift net with fine mesh size (Trivedi and Goel, 1986). Collected benthic invertebrate samples were preserved in 70% Ethyl alcohol and intified them in the lab later.

Socio Economic Survey methodology

Identification of Project Affected Villages (PAVs): Demographic profiles of the district were extracted from Primary Census Abstract, 2011 (National Census, govt. of India, 2011) and list of Project Affected Villages (PAVs) along with list of Project Affected Families (PAFs) were extracted as secondary data (Social Impact Assessment and R & R Plan of EHEP Project, January 2015). A total of 18 villages were identified as PAVs. From this list of PAVs, the number of PAFs for both Dri and Tangon basins of the project area, were identified. The PAVs were further differentiated based on direct (land acquisition) and indirect impacts (other project related activities) of EHEP on the people.

Semi-structured Questionnaire Survey: A standard questionnaire was developed for the collection of primary data from the field. The questionnaire for the survey was pre-tested (trial runs) to assess the appropriateness of the questions. Total 179 households were interviewed in the 22 villages surveyed.

Geospatial database

The GIS database of the Etalin HEP study area was generated by collecting several ground truth data and the data that were acquired from satellite imagery. The landscape features like road, settlements and plantations were generated from the ground truth. The topographic sheets (82P14, 91D02) were used as a reference to affirm the data generated. Geospatial database for the study was developed through the following major objectives.

- Delineation of the ZoI (study area) that comprises the proposed dam construction site and sites identified for other related operation activities (land-acquisition areas), and geophysical and biological attributes (Land Use and Land Cover).
- Preparation of different first level thematic maps, namely contour map, drainage map, vegetation type map (Land Use and Land Cover) and maps containing sampling locations, in order to facilitate surveys for all study components.
- Preparation of biodiversity attribute maps (species richness/abundance /diversity/RET species) of different floral, faunal and social components studied.
- Identification and preparation of critical habitat and grid-based biodiversity value, impact potential and impact significance maps for terrestrial and aquatic components.

Status of Biodiversity values in the Study Area

Flora: A total of 563 angiosperm species belonging to 368 genera and 110 families were reported from in and around the study area, which was based on the cumulative list of plant prepared by combining the present study list and the list collated from the secondary sources (EIA 2015). Eight gymnosperms belonging to five families were reported from the area. A total of 31 species of pteridophytes were recorded from the study areas.

Butterflies: A total of 159 species of butterflies belonging to 77 genera spread over six families were recorded in ZoI, three of which are listed under the Wildlife (Protection Act), 1972. Of the 159 species recorded, 147 species (75 genera and six families) were recorded from Dri and 125 (67 genera and six families) from Tangon.

Odonates: A total of 11 Odonate species were identified in the study area, belonging to five genera and two families.

Spiders: A total of 113 species (43 identified) belonging to 88 genera (84 identified) from 25 families were recorded from the study area. Among the two basins in the study area, 90 species were recorded in the Tangon basin and 68 species recorded along Dri river.

Moths: A total of 51 species of moths belonging to 45 genera (43 identified) from 12 families were recorded in and around the base camp

Amphibians: Within the study area, 14 species of amphibians belonging to 12 genera and six families were recorded. Ten species of amphibians were reported along both Dri and Tangon rivers.

Reptiles: A total of 31 species of reptiles, belonging to 23 genera and seven families, were observed in the study area. Among the two rivers, 26 species were observed along Dri, while 23 species were observed along Tangon river

Birds:

A total of 230 species were recorded from the Etalin HEP study area. Of these 230 species, 205 species were birds of terrestrial ecosystem, while the remaining 25 species were aquatic or dependent on aquatic ecosystem. Of the 16 range restricted species of Eastern Himalayas (Stattersfield *et al.*, 1998), that are resident in Arunachal Pradesh, six species were sighted and recorded in the study area.

Mammals:

Within the ZoI, 21 species of mammals belonging to 19 genera and 15 families were recorded. Of these, 4 species (under 12 genera and 12 families) along the Dri River and 17 species (under 15 genera and 13 families) along the Tangon river.

Five species are listed as threatened under different categories of the IUCN Red list. Of these, one species (Chinese Pangolin) is Critically Endangered (CR), one species (Indian wild dog) is Endangered (EN), two species (Himalayan black bear and Smooth coated otter) are Vulnerable (VU) and one species (Assam Maqaque) is Near Threatened (NT). Three species, Himalayan serow (*Capricornis thar*), Asian golden cat (*Catopuma temmincki*) and Leopard cat (*Prionailurus bengalensis*), were listed as Schedule I of the Indian Wildlife (Protection) Act (IWPA, 1972).

Terrestrial Biodiversity Values of Etalin HEP Study Area

The biodiversity value for mammals, birds, butterfly and vegetation was assessed on the basis of richness of species of conservation significance, threatened (RET) and endemic species. Both Dri and Tangon basin, mammal and bird biodiversity values were assessed as medium, except for grid 39 in Tangon basin which has high bird biodiversity value due to the presence of highest number of RET species (4 out of 12). With respect to vegetation, the Dri basin had medium biodiversity values while very high and high values at the Tangon basin, especially close to the confluence and the proposed dam location. Biodiversity values related to butterflies were mostly high and very high in nature in both Dri and Tangon basins

Aquatic Biodiversity Values of Etalin HEP Study Area

The aquatic biodiversity value was assessed on the basis of species richness, richness of RET species, migratory species, endemic species and the presence of breeding/congregation sites. Along the Dri river, grids with very high and high biodiversity values (15% of total number of sampled grids) were restricted to the upstream sections, close to the proposed dam and submergence area. As compared to the Dri river, Tangon river has a greater number of grids with very high and high biodiversity values (34% of total no. of sampled grids), which are present throughout the river, downstream of the proposed dam location. In all these grids with very high and high biodiversity values, the RET fish species *Schizothorax richardsonii* was present and most of these grids had fish breeding sites and >60% of migratory species found in the study area.

Socio-culture Status and Biodiversity Conservation

As per people's perception, 69.3 % of Project affected families (PAFs) are in favour of the Proposed EHEP Project. They discussed many reasons for the support of the project, which mainly includes, making use of the potential of hydropower, better education, health, infrastructure facilities, job and enhancement of life quality. Only 5 % of the PAFs were not favourable for the proposed project, the main reasons being loss of land and threat to their culture due to influx of outsiders. The remaining PAFs (slightly more than 20%) were neutral for the project i.e. neither in favour nor against the project

Impacts of EHEP on key biodiversity areas & values

Present Mammal Survey: Status of mammalian fauna in the project area confirmed low abundance. Though, many large to medium sized mammals were reported in the upper reaches and in the Dibang Valley, larger cats such as Clouded Leopard, Common Leopard, Snow Leopard and Bengal tiger and ungulates such as Mishmi Takin, Alpine Musk Deer and Red goral were not reported in the study area during this the study period probably due to the location of the project that is in the lower altitude (600 to 1500), which seems to be unsuitable for them.

Existing Biotic pressures – Project Area: Presence of 22 villages within the project area along the Dri and Tangon limbs and associated shifting agriculture, collection of NTFP, timber, bamboo and cane collection, and other resources leading to degradation of the habitat quality in the proposed project area. Further, regular hunting activities could be a significant factor that reduce the faunal diversity and abundance. Even though, they have traditional right to use the forest resources including hunting of animals, these anthropogenic pressures might be limiting the movements of tiger through the Dri and Tangon river limbs because of low prey base.

Existing Vehicle Traffic - Project area: The existing traffic density estimated at eight sampling locations within the project area across three seasons showed traffic density of 479 vehicles/hour. Irrespective of types of vehicle, in any given season (three season)/any location (eight locations), a total of 20 vehicles/hour move in the project area. Extrapolation of the vehicle intensity, 20 vehicles x 8 hours x 365 days showed that a total of 58,400 vehicles move in the project area in a year. The very high intensity of vehicle movements in the study area could also be one of the factors restricting the movement of tigers in the project area.

Local people's Perception: Social survey and interaction with the local hunters to list the species they hunt also confirm that, though they do not hunt tigers due to cultural belief (the *Idu Mishmi* community do not hunt the tiger as it is considered as next to human kin), they opined that, tiger can be seen only after 2-4 days walk from the river limbs to the upper reaches of Dibang valley and they are never seen in and around the project area.

Wildlife Corridor-Tiger movement: 21 mammalian species were recorded in the study area. Capture rate were estimated as ratio of total captures to total camera trap nights. The estimation showed that, along both rivers (Dri = 0.14 and Tangon = 0.11) as well as within the study area (0.11), less than one capture or one species per 1552 trap nights was recorded, indicating very low abundance of mammals in the study area. After deploying 78 cameras for 1552 trap night/days during a four months survey, no tiger was camera trapped, further we could not find pugmarks or scats of tigers during our surveys. Thus, tiger presence in the study area was not established. Low abundances of prey species in general and absence of larger prey species in specific, along with human related disturbances in the area, might have kept the tiger away from the proposed project area. However, Tiger presence and movement in the project area cannot be completely ruled out based on this few months' survey, as they are long ranging species. Hence, long term monitoring of tiger distribution and movements need to be carried out in and beyond the project area covering 10km radius, which includes the eastern and western hill ranges of the Dri and Tangon limbs for the next five years.

A long-term monitoring study on mammalian fauna in DWLS has recorded presence of few tigers outside the DWLS, especially along the southern boundary. The linear distance measured for the three nearest records (locations) of tigers outside the DWLS and between the boundary of proposed project site ranged from 10.2 km to 14.0 km from the north (tail end of submergence) of the Dri and Tangon reservoir areas respectively**.** Another ongoing camera trap study on mammals in lower Dibang valley in Mehao Wildlife sanctuary, in the last eight months (October 2017 to May 2018) reported presence of 22 species of mammalian fauna, which does not include tiger, as till date no tiger has been camera trapped.

Tigers inhabit diverse habitat types, and are distributed even in very high altitudinal range and gradients in this region and they have been camera trapped at an altitude of 3630 m in snow peaks in Dibang Valley District. It has been reported at a distance of 10 km north from the northern boundary of the EHEP study site. The present study did not report tiger occurrence within the project area. The existing cumulative impacts such as, presence of more villages, habitat degradation, hunting, high vehicle movements and low prey base, qualify the project area as not potential habitat for tiger to use or move across. Additionally, considering availability of large extent of suitable habitat in the surrounding environs well above the project area, this hydropower project is not visualized to restrict the movement of tigers occurring in and around the DWLS into any direction in the entire Dibang Valley.

Wildlife Conservation Actions

1. Land acquisition for project - Loss of habitat.
2. Muck-Dump Generation and Handling – Impacts on bio-physical and biological resources.
3. Dust and gaseous emission- Impact of habitat degradation and decrease of faunal diversity.
4. Drilling and Blasting – Impacts of noise and vibration on selected faunal groups.
5. Roads, heavy vehicle movements – Impacts of animal movements and isolation.
6. Unregulated Vehicle Movement - Road mortality on selected faunal groups
7. Overall Project Construction activities - Impact on aquatic ecosystem
8. Overall Project Construction activities - Impacts on RET species / species of conservation significance
9. Overall Project Implementation – Impact of biodiversity use values of local people
10. Influx of Labour Force - Impact on forest resources and cultural values
11. Project Location - Impacts on ecologically sensitive area

Overall 11 types of impacts were identified and evaluated, however suggesting and implementing mitigation and conservation plan specific to each impact is not possible. Prioritising mitigation measures, depend on the availability of land use of operational phase of the project, terrain and topography, overall biodiversity values of the project area and the magnitude of impacts.

PRIORITY ISSUES FOR MITIGATION AND CONSERVATION PLAN

Loss of Habitat

Compensatory Afforestation - is the first plan of action and mandatory to mitigate the loss of habitat due to conversion of forest land for the project implementation. However, in most of the cases, the afforestation program is done just like an ordinary plantation with single species are multispecies of exotic and non-local / non-native species, rather than following scientific approach. Therefore, some scientific approaches are suggested under this mitigation plan.

Impacts of Dust and Gaseous Emission

The impacts on air environment, would indirectly affect the biological values (habitat, flora, fauna) of the project area in terms of habitat degradation. Therefore "**Green Shelter Belt Development – Phyto-remediation",** a biological intervention is suggested for improving the ambient air quality and minimise the impacts of dust and gaseous emission.

Muck-dump

Large quantity muck / waste dumps will be generated due to excavation activity for the tunnels and construction of different project structures. The proposed excavation in different location is kind of mining activity, hence need to strictly follow similar management actions prescribed for mining pertaining to muck/waste disposal. Therefore, Muck/waste dump handing- technique is prescribed to avoid impacts associated to dust emission.

Drilling and Blasting Effects on Selected Faunal Groups

Drilling and blasting for the, construction of HRT, widening and deepening of river beds along the down streams are one of the major supportive activities of the project implementation, that is visualised to have impact on selected faunal groups. Therefore, Technical and Managerial Interventions are suggested to minimise the impacts of noise and ground vibration on ground dwelling fauna groups.

Roads and Vehicle Impacts on selected Faunal Groups

Heavy vehicles movement, and different types and capacities of heavy equipment will be in use for the construction activities and other project structures. The magnitude of vehicles movements and equipment's to be used in terms of numbers and for a longer period of seven years, is predicted to have impact on selected faunal species like – birds, butterflies, herpetofauna and smaller mammals of the project area. Therefore, with understanding of field scenario, mitigation measures are suggested under "Spatio-temporal Regulatory Mechanism" to minimise the habitat degradation, and Technical intervention – to avoid road mortality.

Impact on Aquatic Ecosystem

Many impacts have been discussed in detail on Impacts on River Habitats - Water Quality and Physical Changes (Refer section: 6.8.3) and Impacts on Aquatic Biodiversity (refer Section 6.8.4). This being run-of-river project, and aquatic ecosystem is highly dynamic and sensitive, maintaining the environmental flow or e- flow during the post construction and operational phase is highly crucial. Therefore, selected mitigation measures are suggested specific to aquatic biodiversity in the form of some technical and managerial implications such as: Waste Debris Management, Maintain Stream Morphology, Waste Disposal Management – Industrial and Domestic (by the migrants in the respective appropriate sections.

Impact on RET species

Biodiversity status survey of the project area resulted in high species richness of flora, birds, butterfly and moderate level of other entomofauna, herpetofauna and mammal species, and presence of few RET species. However, low abundance status of most of the species and few individuals of threatened species, along with predomination of forest and river habitat and absence of any critical habitat, it was not possible to suggest any threatened species and habitat specific conservation plan.

- Nevertheless, keeping the importance of biodiversity conservation in total and importance of species of conservation significance (RET& endemic species), different representative Habitat Rehabilitation and Restoration plans are suggested to enhance the overall habitat quality of the study area so that, species of conservation significance can be benefitted.
- RET – Flora: High floral diversity was reported in the project area (498 plant species) with only one threatened plant *Piper pedicellatum*, listed as vulnerable species under IUCN (Table 5.4 & Annexure 5.1). Being endemic to Arunachal and was found in high density in the study area, no any specific conservation plan is necessitated. However, keeping the floral uniqueness of the Dibang valley; diversity of orchids, threatened and endemic species, pteridophytes and lichens and fungai (See Box 6.1), it is recommended to develop a "Threatened Floral Gene-Pool Plot – TFGPP" in the close vicinity of the project area.

Loss of Forest based Natural Resource

The entire local population belong to forest dependent ethnic group and 50% of the project affected people depend on forest resource (NTFP, hunting, fishing and collection of wood resources) for income generation and survival. Further, the locals also hunt 30 and 43 species of mammals and birds respectively from the forest. Therefore, conversion of community land for the project implementation has been visualised to have natural resource depletion for the forest dependent local villagers and also restrict the access to the forest resources, which need to be addressed.

Action Plan – Mitigation and Conservation Plan

The previous sections discussed diverse issues identified during this study and rationale for the implementation of the suggested plans. Further these plans can be grouped into three types such as, 1 Mitigation plans – Mandatory, 2 Conservation Plans – Biodiversity and 3. Conservation plan –Resource enhancement of Peoples' use values. The mitigation plans are mandatory under the MOEF&CC to minimize the impacts that would indirectly influence the biodiversity attributes of the study area.

MITIGATION – MANDATORY ACTION PLAN

Therefore, conservation plan has been drawn taking the existing scenario into consideration and mainly includes general plans for the betterment of wildlife in the project areas. The conservation and management plans suggested here are mainly the issues identified during the survey, specific to biodiversity values of both terrestrial and aquatic systems and the local's perception on the effects on biodiversity use values.

a) **Compensatory Afforestation:** Compensatory afforestation is one of the foremost mitigation measures which come under the compliance of MOEF & CC to address the loss of habitat and associated biodiversity (Table 7.2 of Chapter 7). A total of 26.23 Cr has been budgeted as cost of afforestation as part of the Compensatory Afforestation Programme under the EMP (12.2). So this activity may be covered under EMP ensuring that all the subactivities are carriedout. Hence, budgetary provisions are not provided in Table (i).

b) **Green Shelterbelt- Phyto-remediation:** The major source of dust and gaseous emission are going to come from all the project related land preparation, excavation, construction, handling of waste dump, man power and material transportation, movements of vehicles and underground tunnelling. Plant species that can act as bio-filter agent to control air related pollution problems at population and species levels are recommended as a biological intervention keeping in mind the magnitude of air pollution that is likely to occur. The total budget need for Green Shelterbelt – Phyto-remediation is Rs. 12 lakhs the details of which are given in Table (i).

c) **Muck-dump management and Restoration**: The total quantity of muck to be generated due to excavation and underground tunnel construction etc. is estimated to be 108.9Lac m^3. Dust emission during muck handling, dump formation, runoff muck due to soil erosion, predominately impact on hydrological regime and water quality of rivers. Hence, adoption of technical and biological (dump restoration) mitigations would curtail the possible impacts on aquatic ecosystem A total of 114.73 lakhs has been budgeted as cost relocation and rehabilitation of excavated material under the EMP (7.5). So this activity may be covered under EMP. Hence, budgetary provisions are not provided in Table (i).

d) **Technical and Managerial Interventions – Noise and Vibration**: Increase in movements of vehicles, machineries, workshops, operation of DG sets, drilling and blasting for tunnelling and quarrying are the major sources of noise and ground vibration. Table 7.5 illustrates technical and managerial skills that would minimise the impacts of noise and ground vibration on selected faunal groups when implemented. Some of the interventions include using standard mine explosives, silencers on heavy equipment, PU (Polyurethane) panels in vibrating screens, maintenance of machinery, time restrictions on blasting, monitor noise levels periodically etc. A total of 50 lakhs has been budgeted as cost of Noise Mitigation and Management under the EMP (1.4.1.9). So this activity may be covered under EMP. So budgetary provisions are note given in Table (i).

e) **Technical and Regulatory Mechanism - Mitigation for Faunal Mortality:** Construction activities involve heavy vehicle traffic as well as movement of equipment. The intensity and speed of vehicles specifically carrying manpower - materials are likely to be more compared to the movement of equipments. Therefore, it is important to restrict the speed and frequency of vehicular movements that would minimize the impacts on herpetofauna and ground dwelling mammals. The main mitigation measures suggested for reducing faunal mortality include:

(1) Building of trenches that will act as an underpass for movement of reptiles and smaller mammals for crossing roads.

(2) Erecting sign boards along the road side to control speed limits as well as inform about the animal crossing points.

(3) Educating the drivers for maintaining the decorum of speed limits/blowing horns and making them aware of “Right of way” is first for animals.

The estimated budget for the implementation of this action is Rs. 19 lakhs (Table (i)).

2. BIODIVERSITY CONSERVATION PLAN

This section deals with different species group conservation plans which include Habitat/Niche development/Enhancement. The project study area reported with high species richness of butterfly, birds and moderate richness of herpetofauna, however, due to low abundance of these species, three types of conservation plans are suggested for butterfly species, specific group of hole / cavity nesting birds and reptile species. The details of plan of actions for these are discussed in the following sections.

a) Development of Open Butterfly Parks

Some of project areas like residential colony, labour camp site, office premises, schools and health care centre can be selected for the development of open butterfly parks. A total of 4-5 parks can be developed to attract a portion of the 159 species of butterfly identified. It is proposed to grow two types of host plants, food / nectar plants for adults and larval host plants for laying eggs and larval development in the surrounding areas of the selected sites. In addition to host plants the area should also develop other ornamental and garden species. This might enhance butterfly diversity. Based on the field observation and literature, a total of 23 adult host plants and 13 larval host plants have been identified for the development of butterfly parks. In these parks, signage for the most common species as well as the threatened species depicting basic information on size, life cycle, distribution and ecological importance of butterflies are to be placed. The estimated cost of the five butterfly parks is Rs. 1.3 Cr, the break up of which is given in Table (i).

***b)* Development of Reptile Park/Niche- Facilitating/Enhancement of Microhabitat for Reptile Species**

Two parks with an area of 5 ha each (one in each River limb) would be adequate for this demonstration project. The area selected/identified will be free and far from the human habitation (this could be area marked for waste dumps). Artificial burrows in varying sizes will be constructed using rock heaps and propagated with the seeds of local shrubs and grass species. A portion of waste wood generated during land clearing will be strategically incorporated within this area. These efforts along with Awareness education for safe handling and saving of snake species will help conserve reptiles and their associated habitat. The estimated cost of the two Reptile parks is Rs. 48, 56,000/-, the breakup of which is given in Table (i).

***c)* Facilitating Nesting niche- Deploying Nest boxes for Hole/Cavity Nesting Avifauna**

The plan of action for conserving avifauna is by providing additional nesting habitat and compensate for loss of tree with cavities by provisioning nest boxes based on size of the birds and setting them up before breeding season begins. Monitoring of the nest boxes for at least two breeding seasons is required to know success/occupancy rate. Knowledge creation on ecosystem services of bird community would help generate awareness about the effects of hunting birds and disturbing nest boxes. A total of 50 Lakhs has been budgeted as cost of habitat improvement for avifauna under the EMP (1.3.2.2). So this activity may be covered under EMP ensuring that all the subactivities are carriedout. Hence, budgetary provisions are not provided in Table (i).

***d)* Habitat Rehabilitation and Restoration –Overall Biodiversity and possibly RET Species**

The suggested habitat restoration plans are focused to conserve overall biodiversity values of the project area and through that some of the RET species can also benefit. For example, the compensatory afforestation, has to be implemented in the close vicinity of the project area. Therefore, this habitat restoration program is targeted to restore the land areas of muck dumps (91.79 ha), quarry pits (62.12ha) and 16 ha of labour camp area stated to be restored after construction phase. All the restoration plans and techniques are detailed in table 7.10. of Chapter 7. The estimated cost for the Habitat Rehabilitation and Restoration – Overall Biodiversity and RET Species is Rs. 50.25 lakhs, the details of which are given in Table (i).

e) **Conservation of RET Flora**

The floral species richness is high in Dibang valley and it supports diverse and unique species like orchids and pteridophytes. In addition to some highly threatened (Critically endangered and endangered) and endemic species to Arunachal (**See Box 6.1 of chapter 6**). Therefore, it is suggested to develop Threatened Floral Conservation Plot – TFCP through creating Botanical Garden in the vicinity of the project area (**Table 7.11, Chapter 7**). Development of eco-park or biodiversity preservation plot is one of the biodiversity conservation concepts that has been already been implemented / taken up in many states. The total estimated cost for implementing this specific action on Threatened Floral Conservation Plot (TFCP) is Rs. 29.40 lakhs, the details of which are given in Table (i)**.**

f) **Aquatic Habitat and Biodiversity Conservation**

The proposed construction of 50km approach road and 35km widening of existing roads are expected to adversely impact on both the forest and riverine habitats in terms of loss of habitat and sediment deposition on river system respectively, and thereby affecting the faunal diversity. It was observed that the ongoing road widening project along the stretch between Etalin and Yuron village significant forest cover are being lost (**Plate 7.1 of Chapter 7**). Therefore, to minimize such severe impact on the forest vegetation and as well as sedimentation in the river, Road Waste Debris Management Actions are suggested in **Table 7.12 of Chapter 7**. The estimated cost for implementing this action which is very crucial is Rs.1.03 Cr the break of which are given in Table (i).

g) Maintain the Stream Morphology

A network of 16 major steams feeding water from the catchment area into the Dibang river system has been identified. Road cuttings across these streams would cause a lot of changes in the channel morphology, that may destroy spawning grounds and obstruct migratory routes of the fishes. Therefore, maintaining the stream morphology and flow are very important because the upstream migration of fishes which will be stopped due to the construction of Dams in both the Dri and Tangon rivers. Reduction of the impact of road-cutting through the construction of culverts/small dams across all the streams would be an effective mitigation plan (**Table 7.13 of chapter 7).** The implementation and cost of this action should be included along with the road construction work.

h) Impacts of Hazardous and Domestic Waste Disposal – River System

Impact of hazardous wastes, domestic sewages and solid wastes disposal are very common in any mega developmental project. In general, domestic sewage problems will be attended through construction of ETPs, while rest of the hazardous and solid waste will require proper management especially in the project area that is located in the middle of forest and riverine habitat, which are discussed in **Table 7.14** of Chapter 7. This action needs to be attended to during construction of labour camps and colonies for workers.

3. Action plan for enhancement of bio0resources for people

a) Selected Natural Resource Enhancement

The local villagers depend on diverse forest based natural resource for their livelihood and life supporting systems. The social survey on impacts of project on natural resource showed that fodder and wild edible plant are expected to be impacted at low level, while bamboo collection at moderate level (**Table 6.9 of Chapter 6**). Further, during construction period, the migrant work force is expected to exploit the available natural resources more. Hence under natural resource enhancement, it is recommended to develop Grass Fodder Plot (cost Rs. 1 Cr), Bamboo Plantation (Rs. 70 lakhs), and Wild Edible Plant Garden (cost Rs, 35 lakhs) (Table (i)) to minimize local resource loss and depletion. **Table 7.15 of Chapter 7** enlists the action plan that can be followed for the above mentioned recommendations.

b) Life Quality Enhancement

Local people have an understanding on the need of the project for sustainable utilization of hydro power potential of Arunachal Pradesh, some of their main expectations include job opportunities in the project, additional income sources, better/improved road and transport, education and health care (**Table 5.57 of Chapter 5 lists their views**).

People's perception study on the proposed project showed 70% of the villagers in support of project due to their expectation on many developments, related to infrastructure, education, job, health and overall enhancement of life quality. Therefore, it is a prerequisite for project proponent to fulfil the expectations of the locals for development of socially acceptable, economically feasible and ecologically sustainable activities in ZoI.

Providing job opportunity, creations of supplementary income generation sources, health care, and improved education will fall under CRS compliance. The CRS activities such as Job opportunities, providing vocational courses to families losing agricultural land, improving healthcare and more, suggested in **Table 7.16 of Chapter** 7 would enhance the life quality of the locals thereby making the project socially acceptable and feasible.

c) Development of additional livelihood

Providing jobs to one or more members of all project affected families may not be possible, hence it is recommended to support additional livelihood generation programmes (Listed in **Table 7.17 of chapter 7)** so that, it would bring down their dependency on forest based natural resources. These activities may be taken up as per the project's R& R Plan ensuring all the subactivities are covered. Hence, separate budgetary provisions are provided in Table (i).

d) Improved Health Care and Education

Providing health care and education are again common infrastructure development under CSR activities, **Table 7.18 of Chapter 7** enlists the infrastructure and facility needs.

e) People's Biodiversity Register (PBR) – Programme and Awareness Education

Hunting of wildlife (major source of protein) and use of forest resources (NTFP and other bamboo, cane and wood materials) are community right. People hunt many species of birds (43 species) and mammals (30 species) for their consumption and to some extent for commercial purpose (**Annexure 5.13 & 5.14**). The attitude of commercial use of free resources for additional income is expected to increase many fold due to the influx of large number project manpower / people (outsiders). Hunting being a significant impact and will have direct influence on the population of faunal species, this serious issue should be tackled immediately through series of very strong and effective awareness programs for the targeted groups by initiating the preparation of People's Biodiversity Register – PBR- Programme (**Table 7.19 of Chapter 7**), which will aid in documenting all the local biodiversity and the threats faced. This register will form the baseline for monitoring long term. The total cost for implementation of this action plan is Rs. 25 lakhs. The breakup is given inTable (i)**.**

f) Biodiversity Conservation - Awareness Education

Systematic and well planned series of awareness education camps should be initiated targeting different groups of stakeholders starting from school children, youths, elders of local villages, hunters, migrant project people. This can be done by involving a reputed local NGO with good experience in awareness and education. The themes need to be focused are enlisted in **Table 7.20 of Chapter 7.** The estimated budget for the implementation of this act is Rs.20 lakhs. Table (i) gives the breakup of the budget.

g) Sustainable use of rare resources

Paris polyphylla- this rare wild tuber or rhizome was observed to be overexploited every year by the village youth to make quick and easy money. Extensive collection of cane with the help of labour force from Nepal was observed during the field survey. Exploitation without knowing the status of the resource, its potential and productivity, will lead to over exploitation and diminishing / decrease of the resource. Hence, the actions suggested in **Table 7.21 of Chapter 7,** which include awareness of the nature of this tuber/rhizome among the locals and the issue of over exploitation; would help in sustainable use of such rare and highly commercial resources. The estimated cost for this particular action is Rs.36 lakhs (Table (i) provides the breakup of this budget).

h) Issues related to Migrants, workers on Biodiversity and Culture Values

1. **Illegal Resource Collection and Hunting**

One of the impacts of project on natural resources is its depletion and conflicts that would arise due to sudden increase of 150% of local population because of migrant population, i.e., project associated work force. Their illegal activities in the form of collection of forest resources like; wood and bamboo, poaching and hunting is expected to increase pressure on the natural resources by many folds. Hence, the earlier suggested awareness education programme, very strict enforcement of anti-poaching mechanism, can only help in stopping the hunting associated impacts (**Table 7.22 of Chapter 7**). Total cost for implementing this action is Rs.12 lakhs (Table (i)) and will be done through VNRC & EDC with NGO involvement.

2. **Cultural Issues**

Other impacts related to migrant population are, influence on cultural values, women safety, unnecessary involvement in the tribal community (Idu mishmi's) matters, illegal stay, etc. Therefore, these issues need to be monitored and settled in diplomatically. The ways of handling the issues are discussed in **Table 7.22 of Chapter 7.** Cultural issues being sensitive should be tackled by forming well-informed stakeholders Cultural Issue Committee – CIC and settled through the local legal forum among the village heads and project proponent heads – Public Relation Officer. Judiciary person can be part of this Cultural Issue Committee – CIC. This should be linked with EDC and the suggested actions need be strictly implemented for which the estimated cost is Rs.13 lakhs (Table (i)).

RESEARCH AND MONITORING:

It is important to monitor the ecology and behaviour of fauna and their habitats due to the proposed project, further it is also important to evaluate the effectiveness of this plan on biodiversity. Therefore, the following research and monitoring programmes are recommended:

The monitoring projects are for:

- Monitoring of Aquatic habitat and species of benthic invertebrates and fishes, and other aquatic species along Dri, Tangon and Dibang (below confluence 3-5 km stretch) for five years.
- Monitoring of bird fauna in and around the Etalin HEP Study Area for minimum of three years covering different seasons is recommended to get a better understanding of their status and conservation problems.
- Ecological survey of the Orchids, Pteridophytes, Lichens, and other lower plants for minimum two years, is of prime importance as to know their status, distribution and conservation problems.
- Status survey of *Paris polyphylla* an overexploited, patchily distributed, economically important plant species in and around the Project study area.
- Monitoring of small mammals using camera traps in the Etalin HEP Study Area for minimum of two years is also another important aspect of biodiversity.
- Two years' study on the resource use, availability and means of extraction by local communities needs to be undertaken to get a better understanding of their resource needs and deriving management and sustainable use norms.
- Tracking tiger movements in the region.

All these research and monitoring studies should be long term projects i.e for minimum of three to five years. This would help to develop habitat/site, species /species group, and natural resource specific monitoring protocol which is very important for the long-term conservation of the biodiversity in such a mega developmental project.

Table (i) Budget Layout for the Implementation of the Biodiversity Management and Wildlife Conservation Plan of the Etalin HEP Study Area

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity Total	Main Activity Total
		1	2	3	4	5		
7.4.1	**Compensatory afforestation ***							
A	Nursery Development & Maintenance 2 no.							* A total of 26.23 Cr has been budgeted as cost of afforestation as part of the Compensatory Afforestation Programme under the EMP (12.2). So this activity may be covered under EMP ensuring that all the subactivities are carriedout
B	Seed Collection							
C	Nursery Water Supply & maintenance							
D	Plantation & Maintenance							
E	Site Preparation - Afforestation Plot (including Protection)							
F	Consultant - Nursery and Plantation Techniques (Training & Guidance) + (travel)							
7.4.2	**Green shelterbelt- Phyto remediation – Dust and Gaseous emission**							**12,00,000**
A	Plantation & Maintenance - include protection)	8,00,000	1,00,000	1,00,000	1,00,000	1,00,000	12,00,000	
7.4.3	**Muck-dump management and Restoration ***							* A total of 114.73 Lakhs has been budgeted as cost relocation and rehabilitation of excavated material under the EMP (7.5). So this activity may be covered under EMP.
A	Plantation & Maintenance (include Protection)							
7.4.4	**Technical and Managerial Interventions – Noise and Vibration ***							* A total of 50 Lakhs has been budgeted as cost of Noise Mitigation and Management under the EMP (1.4.1.9). So this activity may be covered under EMP.
7.4.5	**Technical and Regulatory Mechanism –**							

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity	Main Activity Total
		1	2	3	4	5	Total	
A	**Road Mortality of wildlife**							**19,00,000**
A	Awareness to Drivers & others	2,00,000					2,00,000	
B	Preparation and Installing Signages – Awareness	15,00,000	50,000	50,000	50,000	50,000	17,00,000	
7.5.1	**Species Group conservation plan – Habitat/ Niche development.**							
7.5.1.1	**Butterfly Parks - 5 No (1-2 ha each)**							**1,30,00,000**
A	Consultant - Guidance & Training in Developing the parks & trainings support staff (6 months)	6,00,000					6,00,000	
B	Head Gardener - 2 nos. (Care & Maintenance)	2,40,000	2,40,000	2,40,000	2,40,000	2,40,000	12,00,000	
C	Assistant Gardner - 10 nos. (Help Head Gardener	8,40,000	8,40,000	8,40,000	8,40,000	8,40,000	42,00,000	
D	Development of Park (Garden including Fencing + plantation)	50,00,000	5,00,000	5,00,000	5,00,000	5,00,000	70,00,000	
7.5.1.2	**Reptile Park – Habitat / Niche- 2 Nos. 5 ha each**							**48,56,000**
A	Consultant - Expertise in Herpetofauna	4,00,000					4,00,000	
B	Setting up parks including protection + artificial burrows + seed sowing grass, herb, runners, shrubs	30,00,000	2,00,000	2,00,000	2,00,000	2,00,000	38,00,000	
C	Setting up walk way (To be planned & laid before dumping rocks and boulders)	2,00,000	25,000	25,000	25,000	25,000	3,00,000	
D	Incorporation of Waste wood	2,00,000					2,00,000	
E	Security Guard – Stop Trespassing	78,000	78,000				1,56,000	
7.5.1.3	**Facilitating & Enhancing Nesting Niche**							
A	Consultant -Technical inputs, Guidance, Training on Cavity Nesting Bird identification, installation & monitoring of Nest Box							* A total of 50 Lakhs has been budgeted as cost of habitat improvement for avifauna under the EMP (1.3.2.2). So this activity may be covered under EMP ensuring that all the
B	Making of Nest Boxes Different Size (total 400 boxes)							
C	Installation & Maintenance							
D	Monitoring of Nest Box - Biologist							

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity	Main Activity Total
		1	2	3	4	5	Total	subactivities are carriedout
E	Field Assistants - 2							
7.5.2	**Habitat Rehabilitation and Restoration –RET Species**							**50,25,000**
A	Mine Dump Restoration Expert (including travel) @ Rs.1.2 lac per month for 4 months	6,00,000	2,00,000				8,00,000	
B	Setting up the Mine Dumps & other post construction phase project land use area & Preparation for Plantation	12,00,000	1,00,000	1,00,000	1,00,000	1,00,000	16,00,000	
C	Nursery & Plantation (Planting and Maintenance including watering)	12,00,000	2,00,000	2,00,000	2,00,000	2,00,000	20,00,000	
D	Labour charges for maintenance - 5 persons 0n daily wage basis	4,00,000	75,000	75,000	75,000		6,25,000	
7.5.3	**Threatened Floral Conservation Plot– TFCP (2-3 ha)**							**29,40,000**
A	Collection of Seeds	1,50,000	50,000	50,000			2,50,000	
B	Nursery Maintenance (including labour)	2,00,000	50,000				2,50,000	
C	Site preparation + Planting + maintenance (watering and de-weeding)	7,50,000	1,00,000	50,000	50,000	50,000	10,00,000	
D	Head Gardener - 1 nos. (Care & Maintenance)	1,20,000	1,20,000	1,20,000	1,20,000	1,20,000	6,00,000	
E	Assistant Gardner - 2 nos (Help Head Gardener	1,68,000	1,68,000	1,68,000	1,68,000	1,68,000	8,40,000	
7.6	**Aquatic Habitat and Biodiversity Conservation – New Roads & Existing Road Expansion**							1,03,00,000
A	**Waste Debris Management System – Habitat Quality – Restoration**	65,00,000	15,00,000				80,00,000	
B	Nursery Development & Maintenance	8,00,000					8,00,000	
C	Plantation & Maintenance	12,00,000	2,00,000	1,00,000			15,00,000	
7.7	**Natural resource and life quality enhancement**							**2,05,00,000**
7.7.1	**Grass and leaf fodder plots for Mithun**							
A	To be done on need basis - through VNRC & EDC (Seed Money) lump Sum (all inclusive)	75,00,000	25,00,000				1,00,00,000	

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity Total	Main Activity Total
		1	2	3	4	5		
7.7.1	**Bamboo plantation**							
B	To be done on need basis - through VNRC & EDC (Seed Money) lump Sum (all inclusive)	50,00,000	20,00,000				70,00,000	
7.7.1	**Wild edible plant garden**							
C	One in each village - to be done - through VNRC & EDC (Seed Money) lump Sum (all inclusive)	25,00,000	10,00,000				35,00,000	
7.7.2	**Life Quality Enhancement ***							* This activity may be taken as per the project's R& R Plan ensuring all the subactivities are covered
7.7.2.1	**Providing job opportunities (involved in jobs to be created in the project and also in the implementation of BMCP**							
7.7.2.2	**Create Income generation sources /options**							
A	Capacity building in making crafts - improve skills (To be done under EDC program)							
B	Seed money as Loan for setting up / improving business, developing fruit orchards (Under Purview of EDC) – part of livelihood enhancement							
7.7.2.3	**Improved Health Care & Education– part of CSR**							
A	**Improved Health Care**							
B	**Improved education facilities -**							
C	**Encourage sports and games -**							
7.7.3	**Peoples' Biodiversity Register & Awareness Education Programs**							**40,00,000**
7.7.3.1	**People biodiversity Register**							
A	NGO to be involved (take assistance / help of VNRC)	25,00,000					25,00,000	
7.7.3.2	**Awareness - Sustainable Resource Use & Regulation on Hunting of Wild animals**							
A	NGO to be involved - Developing Protocol & Awareness Program (assistance of VNRC & EDC)	10,00,000	5,00,000				15,00,000	

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity Total	Main Activity Total
		1	2	3	4	5		
7.7.4	**Sustainable Use of Rare Resource - *Paris polyphylla* and Cane**							**36,00,000**
A	Awareness on sustainable use	4,00,000	1,00,000	1,00,000			6,00,000	
B	*Understand the distribution, threats and resource potential of Paris polyphylla* and Cane	6,00,000	6,00,000	3,00,000			15,00,000	
C	Experiment – growing *P. polyphylla in ex-situ village land including management*	10,00,000	5,00,000				15,00,000	
7.7.5	**Issues related to Migrants on Biodiversity and Culture Values**							**25,00,000**
A	**Anti-poaching Mechanism**							
	To be done through VNRC & EDC & NGO							
	Signages on effects of hunting and significance of conserving biodiversity	12,00,000					12,00,000	
B	**Stakeholders Interaction – Cultural Values - CIC & EDC**	3,00,000	3,00,000	2,00,000	2,00,000	3,00,000	13,00,000	
7.8	**ESA- Research and Monitoring**	1,60,00,000	60,00,000	60,00,000	60,00,000	60,00,000	4,00,00,000	**4,00,00,000**
Total		**6,43,46,000**	**1,82,96,000**	**94,18,000**	**88,68,000**	**88,93,000**	**10,98,21,000**	**10,98,21,000**

Ten Crores Ninety Eight Lakhs Twenty One Thousand Only

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CHAPTER 1: Introduction

The state of Arunachal Pradesh is the land of rising sun, covering mountains, forest and rivers with highly diverse ethnic population in the country. It is a primarily hilly tract nestled in the foothills of Himalayas. It has wide variation in the topography, which is characterized by mountainous ranges and sub-mountainous terrains along the northern parts. The entire territory forms a complex hill system with varying elevation ranging from 50m in the foot-hills and gradually ascending to about 7000m, traversed throughout by a number of rivers and rivulets (http://www.arunachalpradesh.gov.in/bio-diversity/).

The climate in Arunachal Pradesh ranges from sub-tropical to temperate depending upon the altitude. The regions in the lower belts experience hot and humid climate, with a maximum temperature in the foothills reaching up to 40°C (during the summer). The average temperature during winter ranges from 15 to 21°C, while that during the monsoon season remains between 22° and 30 °C. The areas around the middle belt of Arunachal Pradesh experiences micro-thermal climate, hence are relatively cooler, while an alpine climate prevails in the higher altitudes of the state. Rainfall within the state varies from 1000mm in higher reaches to 5750mm in the foot-hill areas, spreading over 8-9 months excluding the drier days in winter.

The state is drained by several rivers and streams, which originate in higher Himalayas and Arakan Ranges and flow down to form the tributaries of Brahmaputra. Dibang, Kamla, Kameng, Kamplang, Lohit, Noa-Dihing, Siang, Siyum, Subansiri and Tirap are some of the major rivers. The mightiest of these rivers is Siang, called the Tsangpo in Tibet, which becomes the Brahmaputra after it is joined by the Dibang and the Lohit in the plains of Assam (Department of Environment & Forests, Govt. of Arunachal Pradesh -http://arpenvis.org.in/Biodiversity1.htm). The continuous flow of these rivers and rivulets have led to the formation of the broad valleys, which are typical physical features within the state.

1.1 Hydropower potential of Arunachal Pradesh

India ranks fifth in the world in terms of its hydropower potential (148,701MW installed capacity), most of which is contributed by Indian Himalayan Region (IHR; 75%), also known as the water tower of the Earth. The IHR, one of the most important mountain ecosystems of the world, ranges from Arunachal Pradesh in the east to Jammu and Kashmir in the west. Four Himalayan states namely Arunachal Pradesh, Himachal Pradesh, Uttarakhand and Jammu & Kashmir are called 'Power Banks' of India as they carry the lion's share (about 80%) of hydropower potential in India. Given the untapped hydropower potential and the surging energy demand of the country, the Government of India (GOI) has embarked on a fast-track dam-building program. Over the next several decades, the GOI aims to construct 292 dams throughout the Indian Himalaya, doubling current hydropower capacity and contributing ~6% to projected national energy needs by 2030 (Kumar & Katoch, 2014).

The State of Arunachal Pradesh has the largest hydropower potential (~50,000 MW), constituting about 34% of the country's total hydropower potential (Kumar & Katoch, 2014). The state is a part of Eastern Himalayan Ranges and is the most northeastern-most state of the country. It is uniquely situated in the transition zone between Himalayan and Indo-Burmese regions. It has five major river basins namely Dibang, Kameng, Siang, Lohit and Tirap, which form the basis of the vast hydropower potential of the state. Of the state's hydropower potential, only 405 MW has been identified as capacity under operation, while 2,854 MW has been categorised as capacity under construction

(The Hindu, 2017). Under the Prime Minister's 50,000 MW hydropower initiatives, the Ministry of Power, Government of India have identified 89 projects in Arunachal Pradesh. The Preliminary Feasibility Reports (PFRs) in respect of 42 projects having installed capacity totalling 27,293 MW (approx.) have already been prepared (State Hydropower Policy, 2008).

As per the information provided by the Power Department, there are 18 hydropower projects in Dibang basin, out of which 14 hydroelectric projects (HEPs) have been allotted and remaining 4 are yet to be allotted. Apart from the projects on the main river, hydropower projects are planned on all major tributaries and sub-tributaries with installed capacity ranging from 22 MW to 3097 MW. Of these, the largest project is the Etalin HEP (3097MW) which envisages diversion of two rivers - Dri/Dibang (installed dam capacity 1861.6MW) and (Tangon) Talo (installed dam capacity 1235.4MW) in the Dibang Valley of Arunachal Pradesh.

1.2 Biodiversity status of Arunachal Pradesh

Arunachal Pradesh, situated in the Eastern Himalayan biotic province, is part of the Himalayan biogeographic zone (Rodgers et al. 2002). It is among the 200 globally identified important eco-regions, which is to promote the conservation of terrestrial, freshwater, and marine ecosystems harbouring globally important biodiversity and ecological processes. (Olson and Dinerstein 1998). Conservation International has listed its eastern Himalaya "hotspot" into a wider Indo-Burma hotspot, which now includes all the eight states of northeast India along with the neighbouring territories of Bhutan, southern China, and Myanmar (Myers et al. 2000). This state, due to its location at the trijunction of the Paleoarctic, indo-Chinese, and Indo-Malayan bio-geographic regions, nesters ecological conditions and biotic elements from all these regions, making it very rich in floral & faunal resources, with a high level of endemism.

Although the major part of the state is covered with dense forests, the protected area network includes only 11.68% of the forest cover of the state, with two National Parks (2290.82 sq.km / 2.74%) and 11 Wildlife Sanctuaries including one Orchid Sanctuary (7487.75 km^2 / 8.94%). Furthermore, the biodiversity of the state is preserved in three Tiger Reserves (TR) viz., Namdapha TR (2052.82 km^2), Pakke TR (1198.45 km^2) and Kamlang TR (783 km^2) and one Biosphere Reserves – Dehang – Dibang (5111.50 km^2) (Wildlife Institute of India Data Base - 2018).

Habitat diversity

The phytogeographical position, irregular and undulating topography with high hilly ranges and deep valleys accompanied by wide variation of climate and soil have resulted in the formation of varied ecological diversity, which has influenced the rich and diverse vegetation in Arunachal Pradesh (Baishya et al. 2001). The vegetation is classified into five major categories, viz., tropical, subtropical, temperate, sub-alpine and alpine vegetation, and each category comprising subtypes, that is primarily based on altitude and climatic factors (Baishya *et al.* 2001). The Tropical vegetation include Tropical Evergreen Forests, Tropical Semi-evergreen Forests, low hills and plains Semi-evergreen Forests and Riverine Semi-evergreen Forests. The Subtropical vegetation comprise Subtropical Broadleaved Forests and Subtropical Pine Forests. The Temperate vegetation comprised the Temperate Broad-leaved Forest and Temperate Conifer Forest. The Alpine and Subalpine Forest did not comprise any subtypes. The sixth type of forest identified was secondary forest (subtypes - degraded forest, bamboo forest and grasslands, (Kaul and Haridasan 1987)), which is the result of various biotic and abiotic factors. Further, the region's lowland and montane moist to wet tropical evergreen forests are considered to be the northernmost limit of true tropical rainforests in the world (Proctor, Haridasan, and Smith 1998). These six forest types are spread over an area of 66,964 sq. kms, which is about 79.96% of the total geographical area (83,743 sq.kms) of Arunachal Pradesh (FSI 2017). This include, 20,721 sq. kms very dense, 30,955 sq.kms moderately dense and 15,288 sq.kms open forest. The forest cover within and outside green wash area (wooded areas generally shown in light green on SOI toposheets), is 51,407 sq.km, which is 61.39% of the geographic area of the state. Of this, Reserved Forests formed 20.06%, Protected Forests 19.02% and Unclassed Forests 60.38% (FSI 2017).

Floral Diversity

Arunachal Pradesh is considered to be luxuriant in floral diversity, having the highest diversity among the NE states and has been recognized as the 25th biodiversity hotspot in the world (Chowdhery, 1999). It is estimated that over 5000 species of flowering plants, of both vascular and non-vascular origin, occur in this region. In addition to having high diversity of flowering plants, the state harbours habitats and microhabitats for 400 species of pteridophytes, 23 species of conifers, 35 species of bamboos, 20 species of canes, 52 Rhododendron species & more than 500 species of orchids (Department of Forests & Environment, Government of Arunachal Pradesh - http://arunachalforests.gov.in/), with high endemism in higher plant diversity totalling to about 238 species. Orchids are often associated as the "Jewels of Arunachal Pradesh" (**Biodiversity of Arunachal Pradesh - http://arpenvis.org.in/Biodiversity1.htm**). The state is also rich in agrobiodiversity and has been a centre of origin for a number of crop plant species. It is the region's storehouse of medicine plants, harbouring a high diversity of about 500 species.

Faunal Diversity

The taxonomic richness is well represented across different groups ranging from plants, animals, birds, amphibians, reptiles, insect and fishes. The State harbours 20% species of country's fauna, with a very high diversity of invertebrate fauna. The faunal diversity of the Eastern Himalayas, of which Arunachal state form the major part, harbours a diverse assemblage of invertebrates. The prominent invertebrates like butterflies and moths that are known for their ecological service were represented by 713 species of butterflies (47% of butterfly species reported in India) (Das et al. 2018) and 235 species of Moths (Sanyal et al. 2018) respectively. Among the vertebrates, fishes were represented by 259 (Gurumayum *et al.* 2016), amphibians 59, reptile 108 species, avifauna 539 and 154 mammal species (Chandra et al. 2017). Out of 16 primates in the world, seven are found in Arunachal Pradesh. The high endemic and restricted species richness in the eastern Himalayas, has made it one of the high faunal diversity hotspots. Thus, this region is aptly considered as one of the 200 globally important ecoregion, and a part of the Indo-Burma global Biodiversity hotspot (Olson and Dinerstein 2002; Maheswaran, 2012).

Ethnic Diversity

The total human population of 1.38 million, at a density of 17 persons/ sq.km, include 77.06% living in rural areas and remaining are urban population (Census 2011). The total population in the state lives in 3649 villages and small towns. There are in total 1.41 million livestock population in the State (Census 1991). The state has 26 major indigenous groups and 110 sub-groups, 80 of whom are primarily agriculturalists, practicing shifting cultivation on community owned lands. It is unique in having traditional rights of various tribes over land, water and forest within their jurisdiction. Each tribe as a community exercise control over the natural resources within their surroundings, inhabited traditionally by them, and sustainable use of the resources for shelter, cultivation, food and other day to day multifarious uses. More than half of the forests come under the control of the indigenous people. According to tribal beliefs in Arunachal Pradesh, dense forests and big trees are looked upon as ancestral souls, and hornbill hunting is banned during the breeding season. The tiger is sacred as it considered as the 'brother of Tani, the first humans on earth'. Livelihoods of local people have been closely linked and heavily dependent on forest resources since time immemorial. Medicinal plants have come to the rescue of communities, and hence they vigorously guard against the removal of plant and animal species by outsiders. These traditional practices and self-law have paved way to the preservation of the high biodiversity of the area.

Threats to Biodiversity

Large tracts of forest had been lost in Arunachal due to development of pastoral lands, agriculture expansion, shifting cultivation and demand for firewood and timber and construction of hydropower dams. However, with increasing population, development activities, large number of wood-based industries and unsustainable land use practices like jhuming, the pressure on forest resources is consistently increasing leading to their degradation affecting regeneration and productivity. However, of late, forests have been adversely affected by several factors, which include rapid increase in human & livestock population, insufficient infrastructure, and diversion of forest areas for development activities (Department of Forests & Environment, Government of Arunachal Pradesh).

1.3 Overview of hydropower impacts on the biodiversity of AP

a) General overview

Despite being a clean energy source, the impact of hydropower dams and associated activities (e.g., road construction, muck disposal) on the structure, function and ecology of rivers and their floodplains is widely acknowledged. Dams can have cumulative effects many hundred kilometres downstream and upstream of the barrier (Grill et al., 2015). Two biggest impacts of dams on rivers are flow alteration and river fragmentation. Dams act as barriers to river connectivity by altering natural flow and flood regimes of a river. The river flow alteration due to dams has been identified as one of three leading threats to aquatic species (Richter et al. 2003). Disruptions in the natural flow regimes result in physical, chemical, and biological changes within the impoundment which extends downstream of dams as well. Modified flow regime alters thermal regimes, reduces sediment delivery to floodplains and deltas, reduces habitat complexity, alters water quality, and changes river and floodplain morphology, all of which have ecological consequences (Csiki & Rhoads, 2010; Grill et al., 2015; Fantin-Cruz et al., 2015; Sow et al., 2016). The life cycle, distribution, diversity and population dynamics of aquatic organisms such as fishes, macroinvertebrates and aquatic plants, and riparian species are largely governed by the natural variability in different components of the flow regime (e.g., magnitude, timing, duration, frequency) (Bunn & Arthington, 2002; Poff et al., 2010). Altered flow magnitude, duration and frequency have been observed to result in a decline in abundance, richness and diversity of fishes, macroinvertebrates, and riparian plants, reduced habitat for young fishes, loss of sensitive and endemic species, increase in non-natives, altered seedling recruitment, territorialisation of aquatic flora and shift in community composition (Poff et al., 2010). Change in the natural flow regimes such as loss of seasonal peaks of flows can lead to disruption of spawning cues, decreased reproduction and recruitment, change in assemblage structure and diversity, reduced riparian plant recruitment, growth, richness, cover and increased mortality, and invasion of exotic riparian plant species (Poff et al., 2010).

River fragmentation diminishes the natural connectivity within and among river systems (Branco et al., 2014). Disruption of longitudinal connectivity, i.e. linkage between upstream and downstream river sections, has severe consequences for species migration and dispersal, community structure and biodiversity patterns in river channels and riparian zones. Additionally, transport of organic and inorganic matter, energy downstream, into riparian zones and floodplains via longitudinal and lateral connectivity is also significantly impacted (Grill et al., 2015).

Creation of reservoirs above dams is the main contributor to flow regulation. These reservoirs act as a physical barrier to aquatic migratory species. These reservoirs may develop thermal stratification consequently altering thermal regimes, disrupt sediment and nutrient delivery to downstream areas by trapping sediment within the submergence area, and cause geomorphological changes in channels and floodplains (Fantin-Cruz et al., 2015), thereby altering habitats of riverine and riparian species. Since water levels in the submergence area are generally elevated above natural stream levels, it floods the terrestrial-aquatic interface, creating a new littoral habitat with steep banks, simpler aquatic habitat and different physicochemical conditions for aquatic plants and animals. Conversion of lentic habitat to a lotic habitat can lead to dominance of lotic aquatic species over the native free-flowing species thereby altering the natural distribution patterns of aquatic biota and enhance the spread of pests and diseases (Bunn & Arthington, 2002).

Dam impacts of river structure and function such as flow alteration, river fragmentation and submergence not only effects aquatic and riparian species but terrestrial species as well. Forest loss due to submergence or poor longitudinal and lateral river connectivity negatively impacts terrestrial species such as mammals, birds, herpetofauna dependent on such habitats (Pandit & Grumbine, 2012). Additionally, loss of river meso-habitats such as islands, sand bars also impact riverine species dependent on them e.g., river birds, reptiles. Dams indirectly impact terrestrial/riverine species by affecting aquatic food sources such as fishes, macroinvertebrates.

Other activities associated with dam construction and operation such as road construction, installation of buildings, muck disposal, entail forest acquisition and land-use change, thereby causing loss of habitats, migratory pathways, corridors for terrestrial species (Pandit & Grumbine, 2012). Activities such as road construction, muck disposal into rivers also impact river water quality and morphology, consequently impacting aquatic species as well (Trombulak & Frissell, 2000).

b) Hydropower development and its impact on the biodiversity of Arunachal Pradesh

Given the large hydropower potential of the rivers in the state of Arunachal Pradesh, the GOI plans to accelerate the pace of hydropower development in the state to make it the ‘future powerhouse’ of the country. Arunachal Pradesh, having a rich faunal and floral diversity, has been recognized as one of the 34 global mega biodiversity hotspots (Myers et al., 2000) as well as one among the 200 global eco regions. It is also a geologically fragile area. In the light of these facts, it is apparent that the aquatic and terrestrial biodiversity of Arunachal Pradesh is in peril. The proposed hydropower development is likely to impact the habitats and the survival of several endemic and threatened terrestrial species such as the Snow Leopard, Red Panda, Clouded Leopard, Tiger, Arunachal Macaque, Black-necked crane, Mishmi Wren, Rhododendron spp., among many others. These developments will significantly alter the river systems thereby impacting important aquatic species such as Snow Trout, Golden Mahseer and other endemic fish species such as Exostoma.

For instance, in the Tawang basin, 13 hydropower projects with total capacity of about 2890.10 MW have been planned. These projects are predicted to cause substantial loss of extremely fragile mountain ecosystems as well as the rivers. These alterations are likely to impacts several rare, threatened, endemic species of different taxa, e.g., birds such as Black-necked crane, mammals such as Arunachal Macaque, Red Panda, Capped langur, reptiles such as keeled box turtle, red-necked keelback, common mock viper, short-nosed vine snake and plants such as *Acer hookeri, Panax bipinnatifidus, Taxus wallichiana, Toricellia tillifolia.* These projects are also likely to significantly alter the water quality, water availability and the flow regimes of rivers in the Tawang river basins, consequently affecting important aquatic species like Snow Trout and endemic species of periphyton and zooplankton (NEHU, 2014).

Another example is that of the proposed 3000 MW Dibang Multipurpose Hydro-electric Project on the River Dibang. More than 5,000 ha. of biodiverse forests will be directly lost due to the project and the road to the dam site cuts through the Mehao Sanctuary. These and the adjoining forests harbour endangered species such as tiger, leopard, serow as well as the endangered takin, all of which are protected under Schedule I of the Wildlife (Protection) Act, 1972. The grasslands in the area harbour the critically endangered Bengal Florican, a grassland habitat specialist. Other species recorded from the area include the critically endangered white-rumped vulture, the slender-billed vulture and the white-winged wood duck. Approximately 32 lakh truckloads of boulders and 16 lakh truckloads of sand will be mined from the Dibang river bed and its tributaries – demarcated as an Important Bird Area (IBA) and a potential Ramsar site by the Bombay Natural History Society. Downstream propagation of impacts will affect important riverine Protected Areas such as D'ering Sanctuary and Dibru Saikhowa National Park. Additionally, the dam will disrupt migratory pathways for the Vulnerable snow trout, Endangered golden mahseer and Near-Threatened chaguni (SANDRP, 2014).

These above examples give a glimpse of the adverse and possibly irreversible impacts of hydropower development on the aquatic and terrestrial biodiversity of the state that are bound to occur without any conservation planning. The impacts of the biodiversity values and associated services will ultimately affect the social, cultural and economic condition of the human communities residing in the state. However, the actual impact due to a particular project shall be specific to the topography, reservoir capacities, its length, sedimentation and other aspects. MoEF& CC has therefore carried out basin wise studies to delineate the possible impacts from each project and accordingly have come up with projects which are feasible and sustainable.

1.4 Rationale for harmonising hydropower development and conservation planning for sustainable outcomes

Given that less than 25% of the country's hydropower potential has been tapped, hydropower is one of the potential energy sources for meeting the growing power needs (ADB, 2007; Kumar & Katoch, 2014). For developing countries like India, hydropower is an essential energy option which has significant advantages such as: being a renewable energy source, has low greenhouse gas emissions and can generate cheap electricity, flood control and provides water for drinking and irrigation (Pandit &

Grumbine, 2012). Simultaneously, available literature (see section 1.3) reveals that hydropower dams can cause substantial detrimental impacts on the functioning, ecological integrity and productivity of river systems. These impacts are multiple, complex, interactive and cumulative and can have wide-ranging effects across organisational levels (species to ecosystem), spatial scales (local to global) and temporal scales (months to decades) (Grill et al., 2015). Unplanned and unsustainable hydropower development can, therefore, result in adverse effects to the sustainability of natural resources associated with rivers and their floodplains and the wide spectrum of provisioning, supporting, regulating and cultural services provided by them.

Given this premise, it is essential to ensure that water demands for energy and irrigation do not become a cause of receding wildlife habitats and loss of biodiversity resources that may ultimately become compounding factors for accelerated impoverishment of natural resource dependent people. Focused efforts need to be made to protect and prevent loss of habitats, biodiversity and ecological integrity, while still addressing human needs. Development of water resources in a sustainable manner is therefore essential for the continued improvement in the quality of life for humans (Rajvanshi et al., 2012).

Mainstreaming biodiversity conservation into hydropower development offers an efficient and a scientific framework for achieving these goals. Conservation planning address biodiversity conservation by identifying key biodiversity areas (KBAs) and species and implementing appropriate conservation actions (Margules and Pressey, 2000; Nel et al., 2009; Linke et al., 2011; Rajvanshi et al., 2012). It also acknowledges that protecting all areas is impossible in a world of competing human interests and aims to curtail the loss by prioritising conservation areas in a spatially efficient-manner. Quantitative conservation targets such as number and frequency of river /forest types, or species occurrences, or occurrences of rare and endangered species, are a defining characteristic of conservation planning (Nel et al., 2009). Assessing impacts and threats of development projects directly informs conservation strategies, management options and priorities for conservations actions.

CHAPTER 2- Environmental and Technical Considerations

2.1 Project Background

The Etalin Hydro Electric Power Company Limited (EHEPCL) has developed a proposal for 3097 MW Etalin Hydroelectric Power Project (HEPP) in Dibang Valley district of Arunachal Pradesh. The project envisages utilization of waters of Dri and Tangon (also known as Talo) rivers for hydropower generation. The two rivers are tributaries of Dibang River and confluence near Etalin village.

After completing the scope laid out in terms of reference (TOR) for conducting Environment Impact Assessment & Environment management Plan, the project was recommended by Expert Appraisal Committee (EAC) for environmental clearance in its meeting of January 2017. The project was discussed during Feburary 2017, in Forest Appraisal Cmommittee (FAC) for consideration of Stage-I clearance wherein it was advised to Govt. of Arunachal Pradesh to conduct a multiple seasonal Replicate studies from an Internationaly acclaimed Institute. In accordance with the recommendations of “Forest Advisory Committee” (FAC), MoEF&CC and letter no. FOR-279/CONS/2010/Vol-I/836-40 dated 23rd June, 2017 from APCCF & Nodal Officer (FCA), Arunachal Pradesh to Director, Wildlife Institute of India, Dehradun (Annexure-I), a multiple seasonal replicate study on Biodiversity assessment of the project is required to be conducted. The primary scope of the WII study will be to prepare Biodiversity profile of the study area both through field survey as well as through review of published literature and suggest measures for species conservation and management.

2.2 Objectives of the study

In response to this directive, the Wildlife Institute of India submitted a technical proposal to the Department of Environment and Forests, Government of Arunachal Pradesh, for undertaking the desired study. The primary objectives of the study are:

a) To determine the current status of wildlife habitat and distribution pattern of plants, entomofauna, fish, herpetofauna, birds and mammals within the impact zone of the Etalin hydroelectric project (EHEP) area covering multiple seasons.

b) Status and distribution pattern of certain ‘Rare, Endangered and other Threatened (RET) species in the impact zone of the EHEP.

c) Identification of critical habitats, wildlife corridors and migratory paths of RET species in the impact zone.

d) Assessment of the likely impacts due to the construction and operation of the EHEP and associated activities on flora, fauna and their habitats.

e) Develop a Wildlife Conservation Plan in order to avoid/mitigate likely hydropower impacts and conserve key biodiversity areas and species.

2.3 Scope of work and implementation schedule

Based on the objectives of the study, an elaborate scope of work was developed to generate information relevant for developing information and knowledge base with reference to the different biological components included within the purview of consideration for this study. Table 2.1 provides an overview of the specific thrust areas and the tasks envisaged.

Table 2.1 Details of scope of work under various components of the study.

No.	Study Components	Scope of Work
1.	**Vegetation**	• Generation of baseline data of plants in the zone of influence (ZoI) of the EHEP. • Identification of species of conservation significance (SCS) i.e. RET species, endemic species and Schedule-I species (IWPA, 1972) and their habitats. • Identify key biodiversity areas (KBA) on the basis of faunal richness and presence of SCS, particularly in the immediate impact zones of hydropower activities (dam location, submergence area, land-acquisition areas for dumping, quarrying, establishment of colonies etc.). • Assessment of likely impacts of hydropower development on vegetation composition and habitat quality. • Define conservation priorities and plans for addressing threats to SCS and important plant communities within the study area.
2.	**Terrestrial**	• Generation of baseline data of entomofauna (butterflies, moths, dragonflies, spiders), herpetofauna, birds and mammals in the zone of influence (ZoI) of the EHEP. • Identification of species of conservation significance (SCS) i.e. RET species, endemic species and Schedule-I species (IWPA, 1972) and their habitats. • Identify key biodiversity areas (KBA) on the basis of faunal richness and presence of SCS, migratory/dispersal corridors, particularly in the immediate impact zones of hydropower activities (dam location, submergence area, land-acquisition areas for dumping, quarrying, establishment of colonies etc.). • Assessment of likely impacts of hydropower development on species distribution of SCS and KBAs. • Define conservation priorities and plans for addressing threats to SCS and KBAs within the study area.
3.	**Aquatic**	• Generation of baseline data of fishes and benthic invertebrates through survey of Dri and Tangon rivers and their tributaries within the study area • Identify key biodiversity areas (KBA) within the river network by delineating zones of high fish diversity, presence of SCS, migratory pathways, and breeding sites. • Assessment of likely impacts of hydropower development on species distribution of SCS and KBAs. • Define conservation priorities and species/habitat conservation and/recovery/reintroduction plans for addressing threats to SCS and KBAs within the study area.
4.	**Socio-economic**	• Assess and evaluate the potential socio-economic, cultural status of the Project Affected villages of Etalin HEP project. • Conduct structured based interview to generate secondary sources of information about the dependency on forest based natural resources

No.	Study Components	Scope of Work
		(wild fauna & flora) that occur in the study area. • Identify and evaluate the potential socio-economic, cultural impacts of Etalin HEP project on the life quality (economy) and system (culture) of the people. • Define conservation priorities and management to enhance the life quality and conserve the custom and tradition of local communities, thereby to possibly minimise impact on biodiversity of the project area.

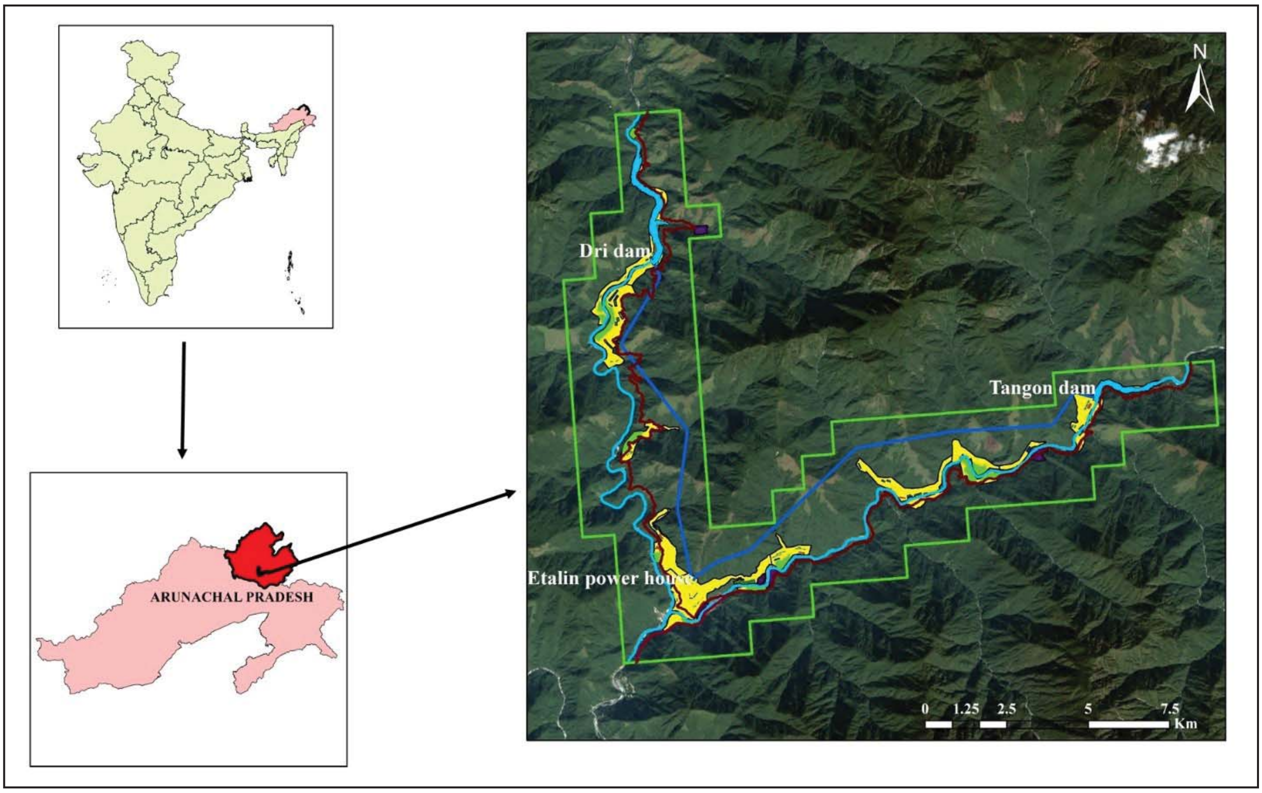
Table 2.2 Task completion

Tasks undertaken	Timeline
Commencement	January 2018
Inception meeting	January 2018
Complete transfer of funds to WII	As per MoU
Site visit	February-June, 2018
Internal review meeting	Monthly
Data analysis and report writing	July-September 2018
First draft of the report	September 2018
Draft final report	October 2018
Final report	May 2019

CHAPTER 3: The Study Area and Project Profiles

3.1 Ecological profile

The proposed Etalin Hydroelectric Project (EHEP) is located in the Dibang Valley district of Arunachal Pradesh (**Map 3.1**). It envisages utilization of the discharges of the rivers Dri and Tangon to generate 3097 MW of power.



Map 3.1: Project Location in the Dibang Valley District, Arunachal Pradesh

The EHEP area falls in the Mishmi Hills which are comprised of parts of districts of Upper Siang, West Siang and entire Dibang Valley of Arunachal Pradesh, India. It is a complex hill system of varying elevations and receives heavy rainfall, up to 4,500-5,000mm annually, in the foothills. The pre-monsoon showers start from March and the monsoon season lasts till October during which the humidity is often over 90%.

The study area is marked by the distinctive peri-glacial topography with sharp crested ridges and sculptured "whale back" hill slopes, marginal glacial features and the presence of terminal and lateral moraines. The valleys in the area are typically U-shaped. It is dominated by steep (>30% slope in about 90% of the study area) to extremely steep slopes (>70% slope in about 45% of the study area). About 72% of the study area and the catchment area of the Dri river lies between 2000 m and 4000 m, while about 15% lies above 4000m and only about 12% lies between 500-2000 m elevation. Most of the catchment area of Tangon river (57%) lies within 2000 m and 4000 m elevation band, while 36% and 6% lies above 4000m and within 500-2000 m elevation respectively. Most of the project activities are restricted to the 600-1500 m elevation zone.

Mishmi hills are part of one of the richest bio-geographic provinces of Himalaya and mega biodiversity hot spot (Eastern Himalaya - Province 2D - Rodgers and Panwar, 1988). Mountainous and undulating topography, high rainfall, climatic variation along the elevation gradients, dense forest and sparse human population in these areas support a phenomenal range of floral and faunal diversity. The rich biodiversity of the region can be attributed to its location at junction of Palaearctic, Indo-Chinese and Indo-Malayan geographic region.

3.1.1 Dri River

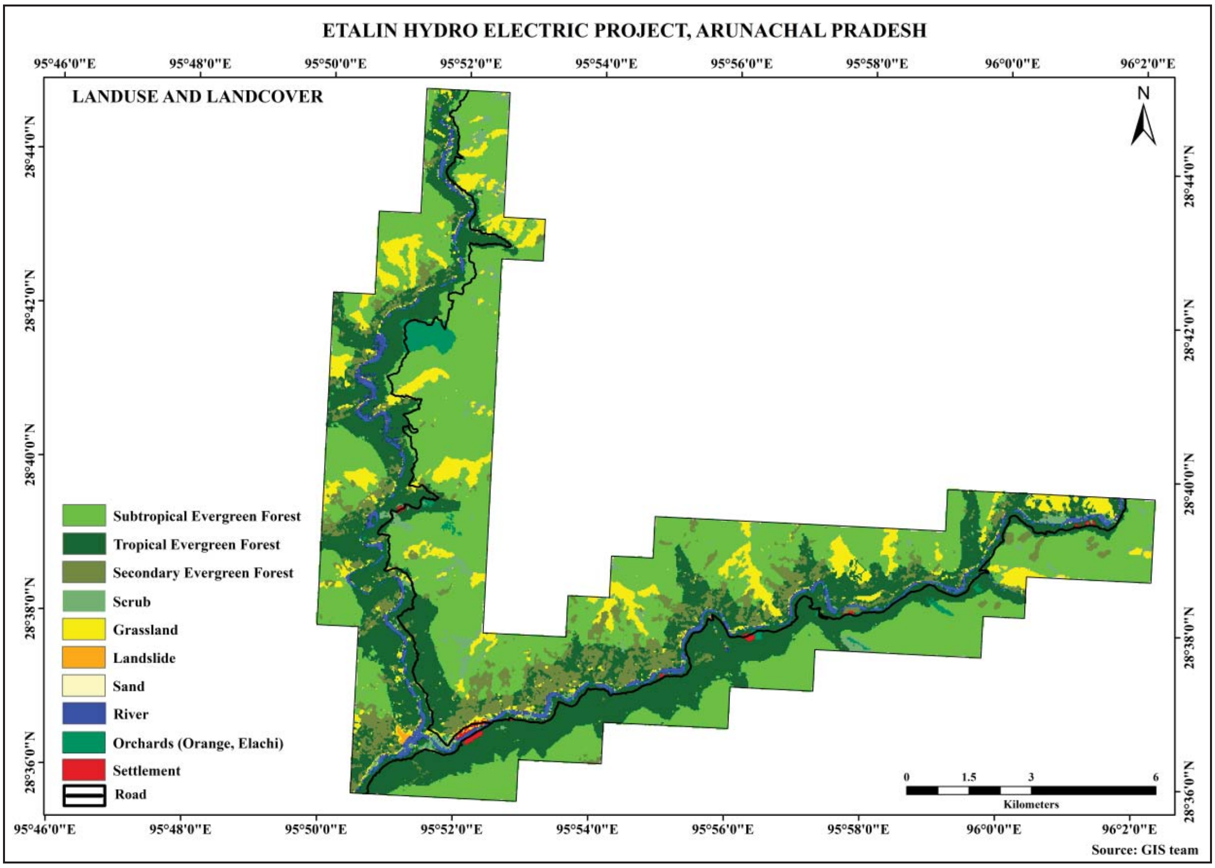
Dri river is one of the major tributaries of the Dibang river, which originates at an altitude of around 5500m from the glacial range of Eastern Himalayas. During its course downstream, it merges with Mathun river and forms the Dri river; after the confluence. The altitudinal range of the area studied along this river, as part of this assessment ranged from 1800m to 700m. It flows north to south and merges with the Tangon river at an elevation of around 700m near Etalin village, the river post confluence is known as the 'Dibang' River. The total length of Dri river up to the confluence is around 110 km and its total catchment area is around 3,750 sq. km. The mean annual inflow is 331.9m^3/s, resulting in a specific run-off of 2848mm/year.

Flora

The forest types spread over the Dri river are majorly; Tropical Evergreen, Tropical wet evergreen and sub-tropical broadleaved forest as per Champion and Seth (1968) classification (Forest stats 2001), and secondary evergreen forest with both banana and bamboo. There were scrub and grasslands above these forested areas (**Map 3.2**). Tree species like *Castonopsis indica, Macaranga denticulata*, *Engelhardtia spicata,* Shrubs species; *Strobilanthes spp*., *Psychotria monticola* and *Piper pedicellatum* and climbers; *Rhaphitophora decursiva*, *Tetrastigma affine* and *Piper clerki* are commonly found in the Dri river.

Fauna

Rich variety of faunal species are found along Dri river. Among the avian species, Whiskered Yuhina (*Yuhina flavicollis*), Black-chinned Yuhina (*Yuhina nigrimenta*) and endemic species such as White-naped Yuhina (*Yuhina bakeri*) are commonly found along the Dri river. Raptors like Crested Serpent Eagle (*Spilornis cheela*) and Common Kestrel (*Falco tinnunculus*) are also commonly seen. Among the mammals, Himalayan Palm Civet (*Paguma larvata*), Indian Muntjac (*Muntiacus muntjac*) and Yellow-throated Marten (*Martes flavigula*) are common in the area. Carnivores, mainly cat species; Golden Cat (*Catopuma temmincki*) and Leopard Cat (*Prionailurus bengalensis*) also occur in the region. Among the entomofauna, Tawny Angle (*Ctenoptilun vasava vasava*) Jaintia Commonflash (*Rapalamissa ranta*) and Common Jay (*Graphium doson axion*) are the common butterflies while Scarlet Skimmer (*Crocothemis servilia*) and Wandering Glider (*Pantala flavescens*) are the common Odonates along this river.



Map 3.2: Different Land Use and Land Cover categories in the Etalin HEP Project Study Area

3.1.2 Tangon River

The origin of the Tangon river is also from the Himalayas. It runs east to west, and is the drainage for many small and large tributaries, such as Noh Naala and Anon pani respectively. The total length of Tangon river from its origin to the confluence with Dri river, is about 91 km. Its total catchment area is around 2,500 sq. km. The mean annual inflow is 211.4 m^3/s, resulting in a specific run-off of 2598 mm/year.

Flora

Same forest types as found in the Dri river (Tropical evergreen and tropical wet evergreen and Sub-tropical broadleaved forest), are found in the Tangon river. Tangon river is slightly richer in terms of plant richness then Dri river, due to comparatively less disturbance. Tree species like *Castonopsis indica, Ficus semicordata and Diploknema butyraceoides*; shrub species, *Piper pedicellatum*, *Rhynchotechun ellipticum* and *Psychotria monticola*; and Climbers such as *Rhaphitophora decursiva, Tetrastigma affine* and *Rhaphitophora hookeri* are the most common floral species found along the Tangon river.

Fauna

Tangon river also has a rich variety of faunal species. Among the avian species, Orange-bellied Leafbird (*Chloropsis hadwickii*), Yellow-bellied Fantail (*Chelidorhynx hypoxantha*) and Rufous-breasted Bushrobin (*Tarsiger hyperythes*) are the common species, and species like Black-capped Kingfisher

(*Halcyon smyrnensis*), Asian Emerald Cuckoo (*Chrysococcyx maculatus*) and Himalayan Cuckoo (*Cuculus saturatus*) were commonly seen during the summer seasons. Among the Mammal species; Himalayan Palm Civet (*Paguma larvata*), Indian Muntjac (*Muntiacus muntjac*) and Yellow-throated Marten (*Martes flavigula*) are common in the region, while Himalayan Black Bear (*Ursus thibetanus*), Himalayan Serow (*Capricornis thar*), Leopard Cat (*Prionailurus bengalensis*), Assam Macaque (*Macaca assamensis*) and Brush-tailed porcupine (*Aherurus marcourus*) are also found along the Tangon river. Among the entomofauna, Paris Peacock (*Papilio paris paris*), Great Nawab (*Charaxes eudamippus eudamippus*), Indian Cabbage White (*Pieris canidia indica*) are the common butterflies in the area, while Blue-tailed Forest Hawk (*Orthetrum triangulare*) and Blue Marsh Hawk (*Orthetrum glaucum*) are the common Odonates in the area.

3.1.3 Dibang River

The Dibang river forms a tributary to the Brahmaputra river and it originates after the confluence of the Dri River and the Tangon river near the Etalin village Headquarters. It has seven major tributaries; Dri, Tangon, Mathun, Eme, Ahi, Emra and Awa (Government of Arunachal Pradesh profile) and terminates into the Lohit river by merging with it near Sadiya which falls in the district of Tinsukia in the state of Assam. Between Emewu (Nizamghat) and Sadiya, the Dibang has a steep river gradient and exhibits braided channel morphology with its width varying from 4 to 9 kilometres (2 to 6 mi). It has a total length/course area of 195km. The Dibang river also lends its name to the District; Dibang Valley district.

3.1.4 Sociology of Dibang valley

Idu Mishmi is the dominant tribe of Dibang valley and are traditionally food gatherers from the wild, therefore are heavily dependent on forest resources for their subsistence. They follow animism and apart from NTFP collection, their major source of income is forest based agriculture wherein shifting cultivation (Jhum cultivation) is practiced.

According to the 2011 census, the Idu Mishmi population is estimated to be approximately 8004 in Dibang valley with an average literacy rate of 64.1% which makes the district the least populated district in the country. The Idu mishmis have their own set of cultural beliefs which they follow before/after varied activities.

3.2 Project Profile

The EHEP (3,097 MW) is a run-of-the-river project which envisages constructing two concrete gravity dams namely (i) a 101.5 m high dam on the Dri river near Yuron village about 22 km from Etalin and (ii) a 80 m high dam on the Tangon river about 800 m downstream of Anon Pani confluence with Tangon river (from the deepest foundation). The water will be diverted via two separate waterway systems to utilize the available head in a common underground powerhouse located just upstream of the confluence of the two rivers. The underground powerhouse is proposed with 10 units of 307 MW each. In order to utilize the releases of flow for sustenance of aquatic life, a dam - toe powerhouse with 19.62 MW capacity on Dri diversion and dam-toe powerhouse with 7.40 MW capacity on Tangon diversion have been proposed.

For this project, a total of 1,155.11 ha of land is required which would be acquired for construction of project components, submergence area, muck dumping, quarrying, construction camps and colony, etc. The total submergence area due to the dams will be 119.44 ha. A total of 18 villages consisting of 285 families will be affected by the proposed project. The estimated cost of the project is Rs. 25,296.95 crores and it is proposed to be completed in 7 years. The salient features of the project are given in **Table 3.1**.

Table 3.1 Salient features of the Etalin Hydroelectric Project (EHEP)

Project Features	Dri River	Tangon river
Dam Height (m)	101.5	80
FRL (m)	EL1045	EL1050
Gross Storage at FRL	21.97 MCM	6.15 MCM
Submergence Area (Ha)	83.32	36.12
Head race tunnel (HRT)	Diameter:11.3m; Length:10722m	Diameter:9.7m; Length:13045m
Tail race tunnel (TRT)	Diameter:11.3m; Length:555m	Diameter:9.5m; Length:544m

3.3 Delineation of Zone of Influence (ZoI)

The impacts due to hydropower development on terrestrial and, particularly, aquatic ecology is spatially and temporally extensive and typically broader than the immediate project area. Given the rapid nature of the study, the study area boundaries were defined by the delineation of the Zone of Influence (ZoI) of the EHEP. The Zone of Influence is defined as the farthest possible distance of influence of the development project, emanating from various impact sources. Identification of impact sources took into consideration the activities, location and extent of (a) Dam, (b) Submergence, (c) Headrace tunnel, (d)Tailrace tunnel, (e) Muck disposal areas, and (f) Built-up areas for establishing various infrastructures including road network. The methodology for ZoI delineation is discussed in detail in **section 4.3**. A detailed insight of the study area derived based on the GIS & RS study done as part of this assessment is provided in the baseline chapter (**Chapter 5, section 5.1**).

CHAPTER IV- Approach and Methodology

4.1 Baseline data collection

The Institute's multidisciplinary team undertook surveys within the Zone of Influence (ZoI) of EHEP, particularly focusing on the immediate impact areas/zones of the hydropower and associated activities e.g., muck disposal sites, quarry areas and other land-acquisition areas. Within these selected project sites, information on different terrestrial and aquatic biodiversity components were gathered. As hydroelectric projects have a direct bearing on the habitats of both terrestrial and aquatic species, specific taxa were targeted for conducting impact assessment. Taxonomic groups that have flagship values and keystone effects, and are highly sensitive to changes in the habitat were selected for the assessment. In this study, mammals, birds, entomofauna, herpetofauna and plants were considered to represent the terrestrial system and fishes and benthic invertebrates were included to represent the aquatic system. The field surveys were conducted between February and May/June 2018, with replicates covering multiple seasons namely, winter / pre-monsoon (February-March), monsoon (April-June).

4.1.1 Terrestrial biodiversity

4.1.1.1 Flora

The proposed Etalin HEP area falls in the Mishmi Hills, one of the richest bio-geographic provinces of Himalaya (Eastern Himalaya – Province 2D – Rodgers and Panwar, 1988). The catchment area of the study area covers all the five major forest types of Eastern Himalaya, viz., Tropical semi-evergreen forests, Sub-tropical wet hill and Assam Pine forests, Wet temperate and Mixed coniferous forests, Sub-alpine, and Alpine scrubs and pastures (Champion & Seth, 1968; Roy et al., 2015). The flora within the ZoI of the Etalin HEP were surveyed in order to generate baseline information and to identify key plant biodiversity areas and key plant species (RET, endemic species) using the following methods:

a) ***Reconnaissance survey***: A reconnaissance survey was conducted in the proposed impact zones of Etalin HEP project area, which include land acquisition areas such as, proposed quarries, dumping sites, submergence areas of both the Dri and Tangon dam sites, and other areas earmarked for infrastructure facilities (powerhouse, workshops and colony area).

b) ***Vegetation sampling***: Quantification of flora (**Plate 4.1**) was done using quadrat method following Misra (1968). At each sampling site, depending on the accessibility and availability of space, 5-12 quadrats, each of 10x10m size were laid randomly for sampling trees. In each plot, trees were identified to species level and number of individuals of each species and girth at breast height of all trees (GBH, at 1.37m) wee recorded. A plot of 5x5m was laid within the larger plot for sampling seedlings/recruitment class (10-30 cm gbh with 1ft in height) of trees following a nested study design. Within this plot, list of shrubs and climbers were enumerated. To study the ground layer (herbaceous layer) 2, 1x1m plots were laid and individuals of respective species were counted.

Plate 4.1: Vegetation Data Collection in Etalin HEP Project Study Area

Specimen Identification

Extensive floristic survey/inventory was conducted along accessible trails in the forested areas as well as motorable roads. All species encountered was photographed and field notes including site description were noted down. Site description of the locality includes project land use, GPS locations, local name of the plant and its use (if known), habitat found, a brief description of the plant, and date of survey. Standard herbarium preservation and field techniques protocol given by Calabrese (2005) was followed. The unidentified specimens were confirmed to the species level at the Botanical survey of India, Itanagar.

Sampling Efforts

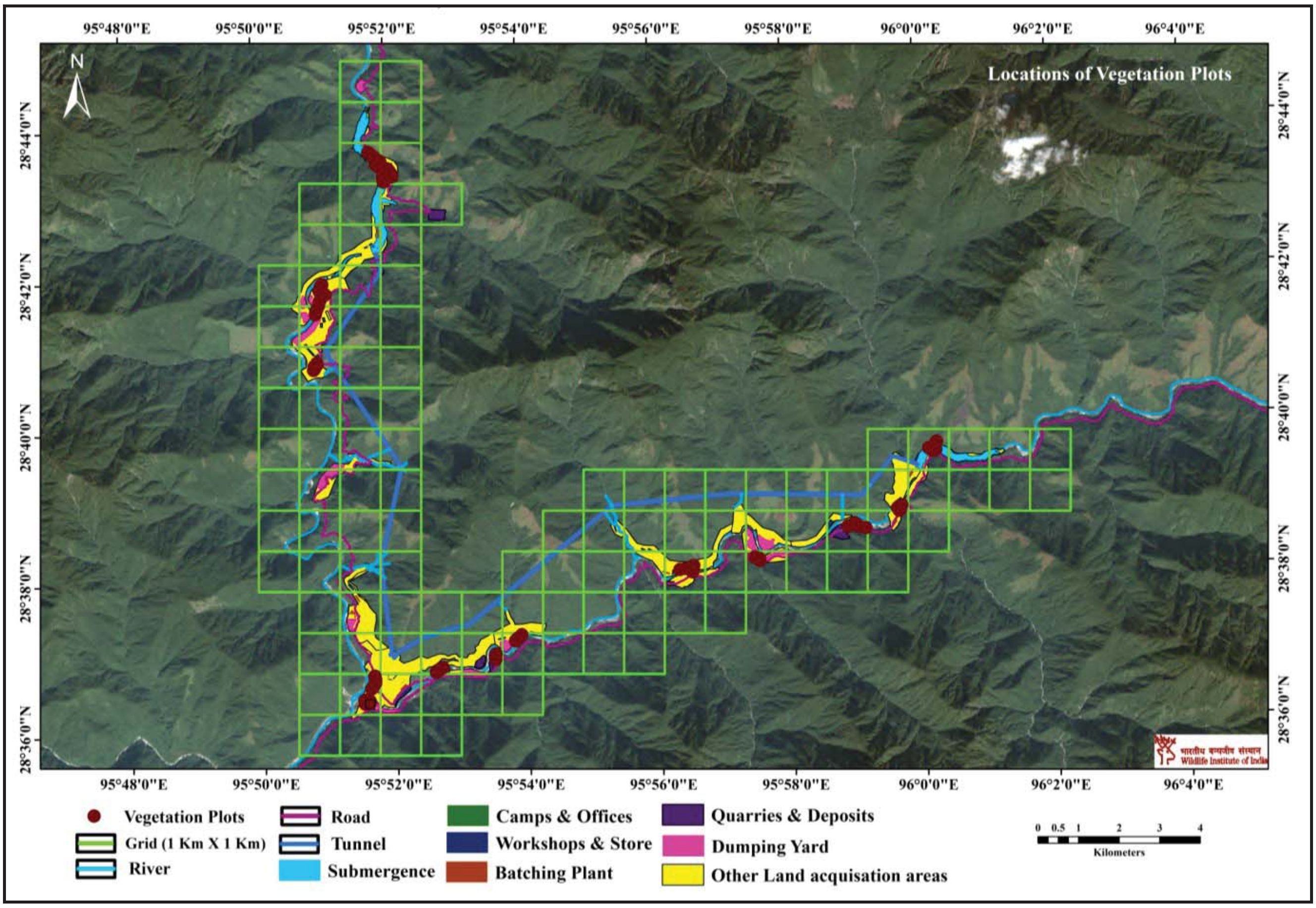
A total of 15 sites were selected randomly depending on accessibility and approach within the ZoI, that include the land acquisition sites along both the Dri and Tangon rivers. Within these 15 plots, spread over the ZoI, on the whole, 133 plots for trees and shrubs and 266 plots for herbs, were quantified. Project land use specific distribution of number of plots sampled are detailed in **Table 4.1**. The locations of the vegetation sampling points are shown in **Maps 4.1 & 4,2.**

Table 4.1. Details on sampling effort in different Impact Zones for the floral component

Impact Zones	Dri			Tangon			Total		
	Tree	Shrub	Herb	Tree	Shrub	Herb	Tree	Shrub	Herb
PH&C	17	17	34						
DSA	26	26	52	12	12	24	55	55	110
DS									
QS				6	6	12	6	6	12
DY	6	6	12	14	14	28	20	20	40
W/B	9	9	18	8	8	16	17	17	34

Impact Zones	Dri			Tangon			Total		
	Tree	Shrub	Herb	Tree	Shrub	Herb	Tree	Shrub	Herb
CCO	5	5	10	4	4	8	9	9	18
OT	8	8	16	10	10	20	18	18	36
NIZ				8	8	16	8	8	16
TOTAL	**71**	**71**	**142**	**62**	**62**	**124**	**133**	**133**	**266**

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones



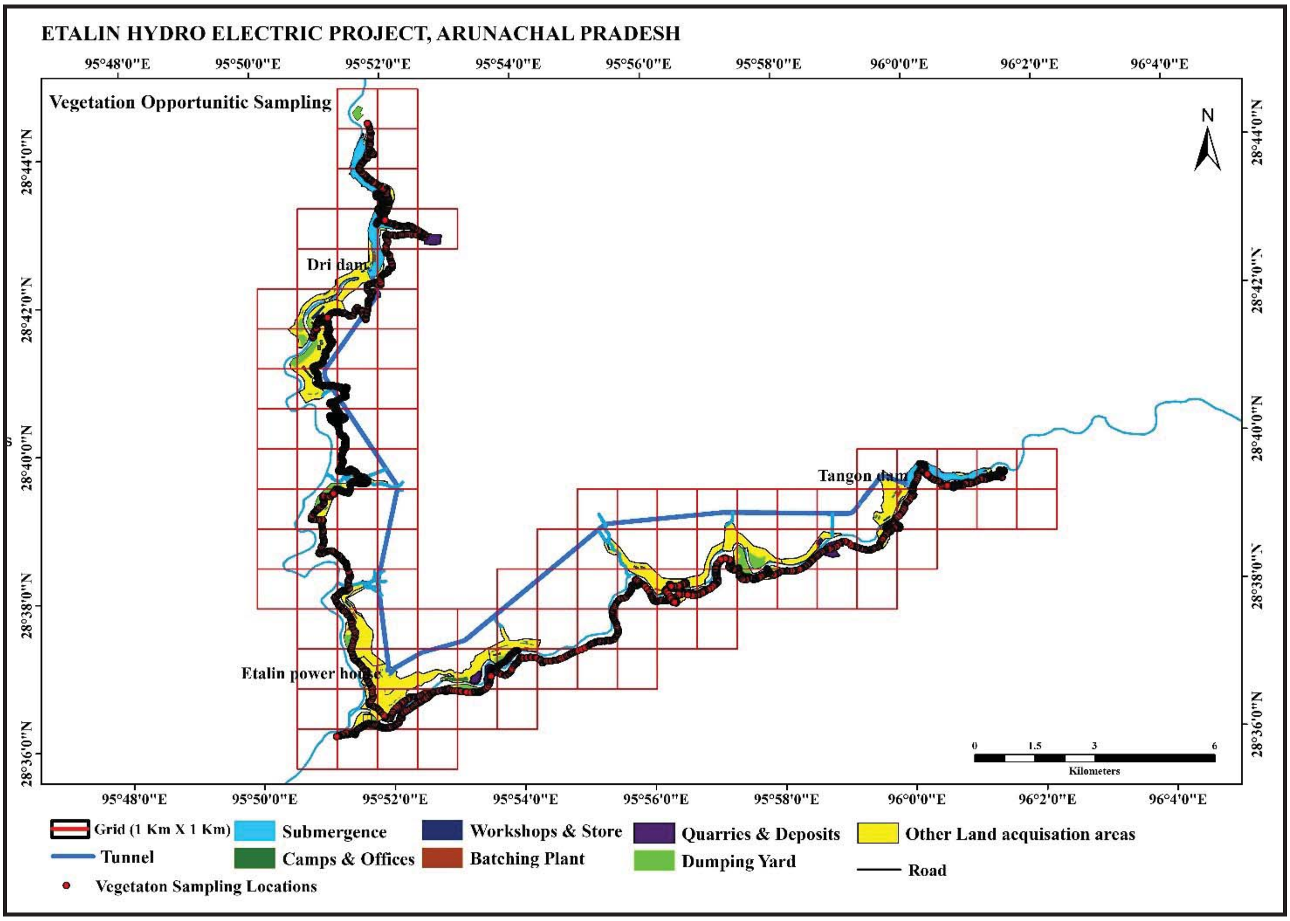
Map 4.1: Location of Vegetation Sampling Plots

Data analysis

Species richness was based on total number of species in an area. Shannon diversity index was calculated using the analytical software Past 3. Density, frequency and abundance were estimated following Curtis and McIntosh (1950), Misra (1968) and Muller-Dombois and Ellenberg (1974).

Frequency: It is the number of sampling units (%) in which a particular species occurs. Frequency of each species is calculated as follows:

$$Frequency\ (\%) = \frac{Total\ no.of\ plots\ with\ species\ presence}{Total\ no.of\ plots\ sampled} \times 100$$



Map 4.2: Locations of Vegetation Survey Routes / Trails

Density: It represents the numerical strength of a species in the community. The number of individuals of a species in a unit area, is its density. Density per unit area was calculated for all the species.

$$Density\ per\ plot = \frac{Total\ no.of\ individuals\ in\ all\ plots}{Total\ sampled\ area}$$

Abundance*:* This is the number of individuals of any species per sampling unit of occurrence. It is calculated as:

$$Abundance\ per\ plot = \frac{Total\ no.of\ individuals\ of\ a\ species\ in\ all\ plots}{Total\ no.of\ plots\ with\ species\ presence}$$

Basal Area*:* Basal area refers to a ground actually penetrated by the stem. It is one of the important characters determining dominance and the nature of the community.

$$Mean\ Circumference = \frac{Sum\ of\ all\ GBH\ of\ a\ species}{Total\ no.of\ individuals\ of\ a\ species}$$

$$Mean\ Basal\ Area = \frac{C^2}{4\pi}$$

$$Total\ Basal\ Area = Mean\ basal\ area \times Density\ (per\ unit\ area)$$

Importance Value Index (IVI)*:* IVI of a species in the community gives its relative importance. It is the sum total of value of relative density, relative dominance and relative frequency.

$$Relative\ Density = \frac{The\ density\ of\ a\ species}{Total\ density\ of\ all\ species} \times 100$$

$$Relative\ Frequency = \frac{Frequency\ of\ a\ species}{Total\ frequency\ of\ all\ species} \times 100$$

$$Relative\ Dominance = \frac{Total\ basal\ cover\ of\ a\ species}{Total\ basal\ cover\ of\ all\ species} \times 100$$

The IVI is attained by combining the previous equations:

$$IVI = Relative\ Density + Relative\ Frequency + Relative\ Dominance$$

4.1.1.2 Entomofauna (Arthropods – Butterflies, Moths, Odonates and Spiders)

Effective bioindicators are characterized by attributes such as wide distribution range, taxonomically and ecologically well-known, specificity to the habitat requirement, several direct and indirect relationships with other organisms (Ferris and Humphrey, 1999; Rainio and Niemelä, 2003) and representative of several ecosystem components (Landres et al., 1988). Arthropods have been well established as efficient indicators of ecosystem functions and are recommended for use in conservation planning (Rosenberg et al., 1986; Kremen et al., 1993; Finnamore 1996). They have the widest range of microhabitat occupancy and play diverse ecological roles, than any other group of animals (Longcore, 2003). Further, these organisms have been used to assess habitat quality and habitat differences (Niemelä et al., 1993; Pollet & Grootaert 1996; Rykken et al., 1997; Kitching et al., 2000; Gibb & Hochuli 2002). Small body sizes, short generation time (Kremen et al., 1993), high sensitivity to temperature and moisture changes (Schowalter et al., 2003), and provision of ecosystem services (Longcore, 2003) make arthropods excellent indicators of integrity of forest management practices (Samways, 1994; New, 1995, 1998; Progar and Schowalter, 2002). The relationship between vegetation characteristics and arthropods is important for two reasons. First, the structure of arthropod communities at restored sites may be influenced by the conditions created by the plant community. Studies of old-field succession and restorations have shown a positive relationship between plant species and structural diversity and arthropod diversity (Murdoch et al., 1972; Southwood et al., 1979; Hawkins & Cross 1982; Stinson & Brown 1983; Parmenter & MacMahon 1987, 1990).

In this study, the following four different arthropod taxa were assessed, as each group specialize in occupying their own niche and act as indicators of the state of that microhabitat and habitat:

a) ***Butterflies and Moths***: Butterflies have been used extensively as indicators of ecosystem health mainly because of their strong associations with habitat variables, such as sunny conditions, flower-filled fields, meadows, hilly regions, edges of woodlands, and abundance of herbaceous plants (Niemelä and Baur, 1998; Makino et al., 2006; Nelson, 2007; Halder et al., 2008). Butterfly diversity assessment would indicate the presence of seminatural conditions; specifically, flower abundance, understory herb cover, and vegetation diversity that directly promote butterfly diversity in an ecosystem (Inoue, 2003; Kitahara, 2004; Barlow et al., 2008; Bergman et al., 2008; Halder et al., 2008; Kitahara et al., 2008). It is presumably because of their association with richness of vascular plants, nectar plants and herbaceous plants (Niemelä and Baur, 1998; Grill et al. 2005; Kitahara et al. 2008).

Moths are used as indicators of vegetation recovery after environmental disturbance (New, 2004). Some moth families/subfamilies, for example Arctiinae, Catocalinae, Heliothinae, Noctuinae, Hermeniidae, and Phycitinae) respond positively to disturbances, while other families such as Ennominae, Geometrinae, Epipaschiinae, Lymantriidae, and Anthelidae respond negatively to disturbance regime (Kitching et al., 2000).

b) Dragonflies: Surveys of dragonfly communities have become essential tools for the ecological assessment of aquatic systems, particularly of standing waters, wetlands and floodplain areas (Maleque et al., 2009). Dragonflies are reliable indicators for evaluating the ecological quality of land–water ecotones, habitat heterogeneity (e.g. bank morphology and aquatic vegetation), and of hydrological dynamics of water bodies (Schmidt, 1985; Corbet, 1993; Samways, 1993; Chovanec and Raab, 1997; Chovanec, 2000).

c) Spiders*:* Spiders have been used as successful bioindicators of forest management practices because they can be easily identified and are differentially responsive to natural and anthropogenic disturbances (Pearce and Venier 2006). They are indicators of ecosystem changes caused by clear-cutting, forest fires, vegetation development, and complexity of forest stands (Buddle et al., 2000; Oxbrough et al., 2005). Spiders with high dispersal ability may persist in isolated vegetation patches, while species with poor dispersal ability may disappear from small and greatly isolated land fragments (Buddle et al., 2000; Pearce and Venier 2006).

Existing Work

Earlier works on butterflies from this region are in the form of targeted single species survey records (Roy, 2013; Roy, 2017; Singh, 2013), but mostly from higher elevation regions (near Anini), and a well-documented book on butterflies of Arunachal Pradesh by Singh and Das (2016). The butterfly data, thus, can act as a cross-reference and specific pre-monsoon record for the region. It would also probably aid in reporting some species that are not listed in the above-mentioned book.

No concise inventory and/or checklist of moths or odonates are available for the specific study site and thus, whatever fraction of moths and odonates we have, can be a small step towards more extensive studies that can be undertaken in future.

There are no Araneae records from the Dibang Valley and this study is the first attempt at establishing a baseline inventory. Although, given the seasonal and time limitations, the samples were mostly sub-adults and juveniles. A genera level identification is also the first big step to opening up research possibilities. Overall, this study component is expected to add more information on these species' groups of this area as well as biodiversity attributes of the present study.

Sampling

The following methods were used to sample arthropods within the project ZoI:

a) *Line Transect*: All selected faunal taxa / groups were surveyed following line transects of 1km length with a fixed width of 2-3m for spiders, 10-15m in forested and 20-25m in open habitat on both sides for butterflies and 10m on both sides for dragonflies, along motorable roads. This was walked during daytime/daylight hours (9:00-10:00 hrs and 13:00-14:00 hrs). GPS coordinates were recorded at the starting and ending points of the transect and for each species sighted, including the RET species.

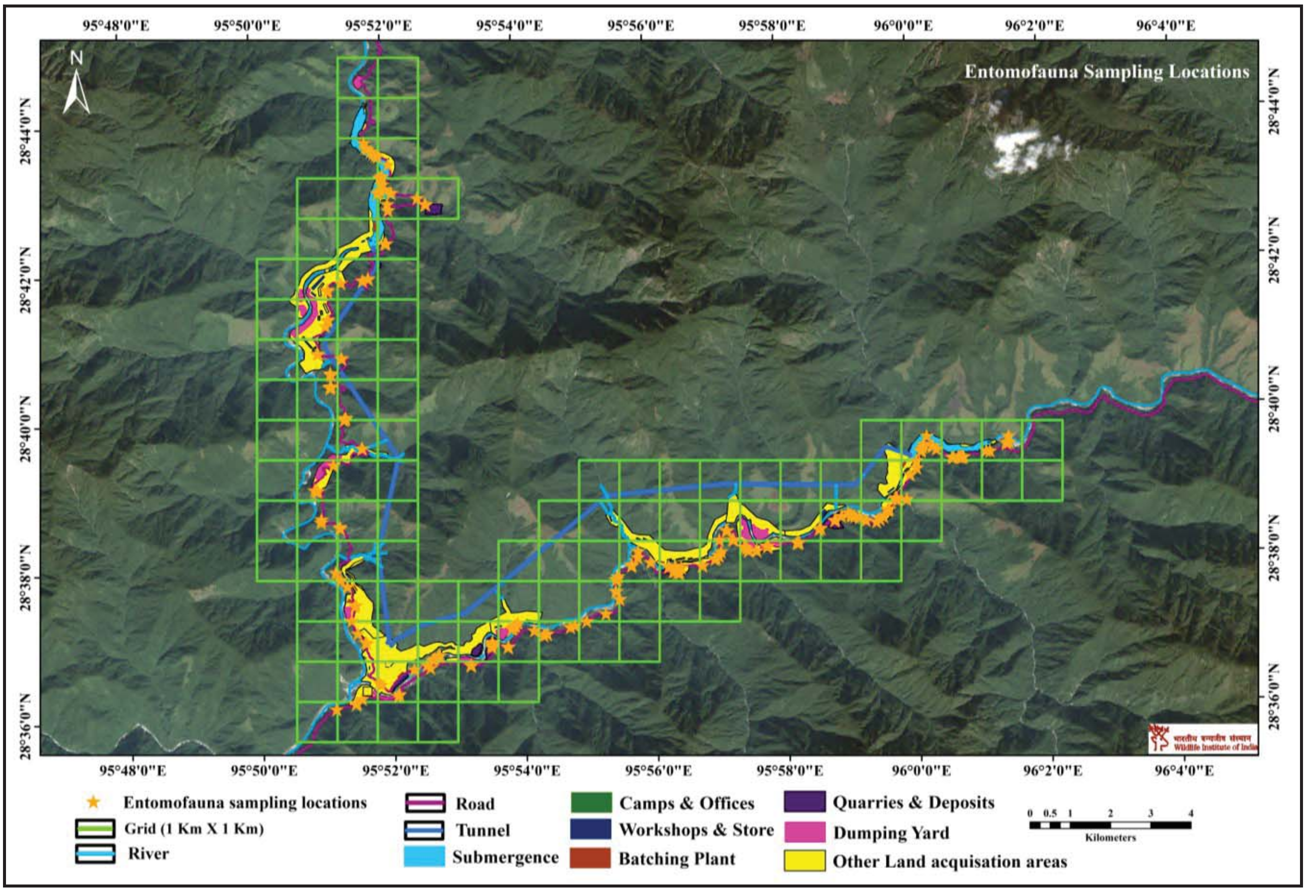
b) ***Forest trail transects:*** These were of varying lengths traversing usually along accessible forest trails within and adjoining high impact zones.

- Butterflies were photo documented along aforementioned transects and identification was done referring to guides and online information platforms (namely, Smetacek, 2017; Singh and Das, 2016; and www.ifoundbutterflies.org).
- *Dragonflies* were surveyed through photo documentations along the same transects, walked for butterfly observations, and later identified (www.indianodonata.org).
- *Spiders* were surveyed along the aforementioned transects and collected in vials, followed by preservation in 70% alcohol for laboratory identification. Collection methods were based on sampling protocols given by Coddington et al., (1991), but were mainly restricted to active hand collection and sweep netting. Efforts were made to avoid repetitive sampling, i.e., sampling the same location / site again. Samples were identified at genus level with the aid of Olympus SZX7 Stereo Microscope by referring to existing identification guides and records (Tikader and Malhotra, 1980; Tikader, 1982; Sethi and Tikader, 1988; Majumder and Tikader, 1991; Song et al., 1999; Jocqué, et al., 2006; Koh and Leong, 2013; World Spider Catalog**,** 2018).
- For *moths*, opportunistic photo documentation was done in and around the base camp, located 10 km away from Etalin village along Tangon river. These were later identified and listed.

A total of 63 transects for spider and 65 transects for butterflies and dragonflies were walked (**Map 4.3**), covering a total distance of 128 kms. In addition, forest trails (cumulative distances of 16km) for assessing the three groups was also surveyed (**Table 4.2**).,

Table 4.2: Details on No. of Transects walked for assessing Butterflies, Odonates and Spiders

Groups	No. of Transects			
	Dri (km)	Tangon (km)	Forest Trails (cumulative km)	Total (km)
Spiders	35	28		72
Butterflies and Dragonflies	38	27	7	72
Total distance surveyed (km)	**73**	**55**	**16**	**144**



Map 4.3: Entomofauna Sampling Locations (Line Transects & Forest Trails)

Plate 4.2: Entomofauna Survey in Etalin HEP Project Study Area

4.1.1.3 Herpetofauna

In general, the amphibians and reptiles were assessed along the existing roads running along the eastern side of the Dri River from the confluence to the tail end of the submergence zone of proposed dam and along the south eastern slopes of the Tangon River, from the confluence to the tail end of the submergence zone of that proposed dam. In addition, all the existing paths were also walked till where it was accessible.

It is important to mention here that most of the vegetation cover and microhabitats were disturbed already due to roads being laid (expansion of existing road) by National Highway Authority along the Dri river and construction of new bridges by BRO for defence purpose along the Tangon river. Hence the efforts yielded only less information.

Discussion with the local villagers/community using pictorial representation of herpetofauna also helped to document the species found in the area. Further, attempts were also made to identify the genus or species encountered in the form of fresh road kills, dead skins removed by the reptiles (specifically snakes), and that were found dead.

a) ***Amphibians***: The amphibians were assessed using Visual Encounter Survey (VES; Steinke, 2016), along the roads and adjacent to streams. They were searched along the specific patch or microhabitat, as these are mostly habitat associated group (water related). Frog calls were also used to record the species (Allison and Englund, 2005). Time Constrained Search method (Welsh, 1987) was also followed wherein a specific micro habitat was searched intensively for 5-10 min depending on the size of the microhabitat. Additionally, other opportunistic sightings were also recorded (**Plate 4.3**).

b) ***Reptiles****:* This group includes, lizards, snakes, turtles and tortoise. The study period involved largely winter/ post monsoon and pre-monsoon seasons, recording amphibians and reptiles was a difficult task. Since the activity pattern of most of the amphibians and reptiles is limited during winter and pre-monsoon months, assessing their richness and distribution pattern was challenging task during the study period. Besides VES method, we relied on other opportunistic sightings and local knowledge (Steinke 2016; Allison and Englund 2005). All reptiles within an observable distance, depending on visibility, on either side for the entire length of the route, were recorded. Further, as in the case of amphibians, a 20-25 m^2 plot was laid following Time Constrained Search method (Welsh, 1987). Basically, the search involved turning of rock boulders, fallen logs, searching in the leaf litters and peeling off bark of dead trees, and so on.

The details on the distances covered and number of plots searched for herpetofauna are given in **Table 4.3**.

Table 4.3: Details on Sampling done for Herpetofauna

Groups	Distance Walked in km		No. of Plots /patches
	Road Transects	Paths & Trails	
Amphibians	32..5	3.0	15 (5-10 mins Search)
Reptiles	25.5	5.0	20 (20-25 m^2 plots)

The data thus collected on both groups is used to describe the taxonomical status along Dri and Tangon rivers, different groups within amphibians and reptiles, their richness status and the species of conservation significance.

Plate 4.3: Herpetofaunal Survey in Etalin HEP Project Study Area

4.1.1.4 Avifauna

Birds are significant ecological indicators because of their high detectability compared to other groups, mainly due to their widespread presence and diversity in most habitats (Bibby 2002) and sensitivity to natural and anthropogenic environmental alterations (Fleishman and Mac Nally 2006). They also act as effective ecological indicators at a comparatively large spatial scale. For example, many species' distributions are affected by habitat fragmentation or other habitat structural parameters (Askins and Philbrick 1987, Freemark and Collins 1992, Murray and Stauffer 1995, Wilson et al. 1995, Schmiegelow et al. 1997). Many birds occupy high tropic levels and may integrate functional disturbance at lower levels (Cody 1981, Sample et al. 1993, Petterson et al. 1995, Rodewald and James 1996). Bird community composition reflects inter specific dynamics and population trends (Cody 1981). In addition to their role as indicators, the presence of several charismatic species within this group and their inclusion into monitoring programs provides an effective way of increasing awareness of biodiversity threats (Gregory et al. 2008). Birds also provide many direct and indirect ecosystem services and are efficient indicators of the status of ecosystem health.

The State of Arunachal Pradesh is documented as one of the topmost birding areas in the world wherein, more than 700 species of birds have been recorded by Chowdhary (2006). A new taxon of monal pheasant *Lophophorus spp.* (Kumar and Singh,1999) and Bugun Liocichla (*Liocichla bugunorum)* (Athreya, 2006) has also been documented and reported as first record for science from this State.

Sampling

Based on an initial reconnaissance survey along Tangon River and Dri River, the following sampling methodology was selected to fulfil the study objectives:

A systematic sampling strategy was used. The study area was stratified based on different project land use/activities-based categories, wherein transect routes close to the impact zone and land acquisition areas that involve major construction activity were identified and sampled over a spatial scale and time period (February to May 2018).

a) ***Point Count***: This method is used for highly visible or vocal species, often passerines, in a wide variety of habitats and is particularly suited to dense vegetation (Sutherland 2006). The point count method involves recording birds seen and heard from a fixed location and period of time at a distance of equal intervals (Bibby et al. 1992). The time period for each point count station was 20mins and the distance interval between two stations was set at 500m. Birds were recorded at each point over a radial distance of 0-15m depending upon the habitat and terrain conditions. The point counts were done during morning (0630-1030 hrs) and evening (1530-1700hrs) hours, when the birds are more active. Various habitat parameters were recorded within the 10m radius circular plot at each sampling Point.

b) ***Line Transect (McKinnon's Species richness method)***: The detectability of a species varies according to locality and the ability of the observer. For assessing the avian species richness, we used McKinnon's species richness method (McKinnon and Philip 1993). This method involves, preparing list of all species until one has a certain number (10 species) on the list. Species recorded once should not be included again within that particular 10 species list. Once list of 10 is over, then start again, to make a second list of 10 species (the species recorded in the first list if encountered during current listing can be included again); and so on. All the birds sighted (including birds in flight) and identified by calls, were recorded during the sampling, along with their strata and activity. Various habitat parameters were recorded including the starting and ending time, and distance to the transect or survey route.

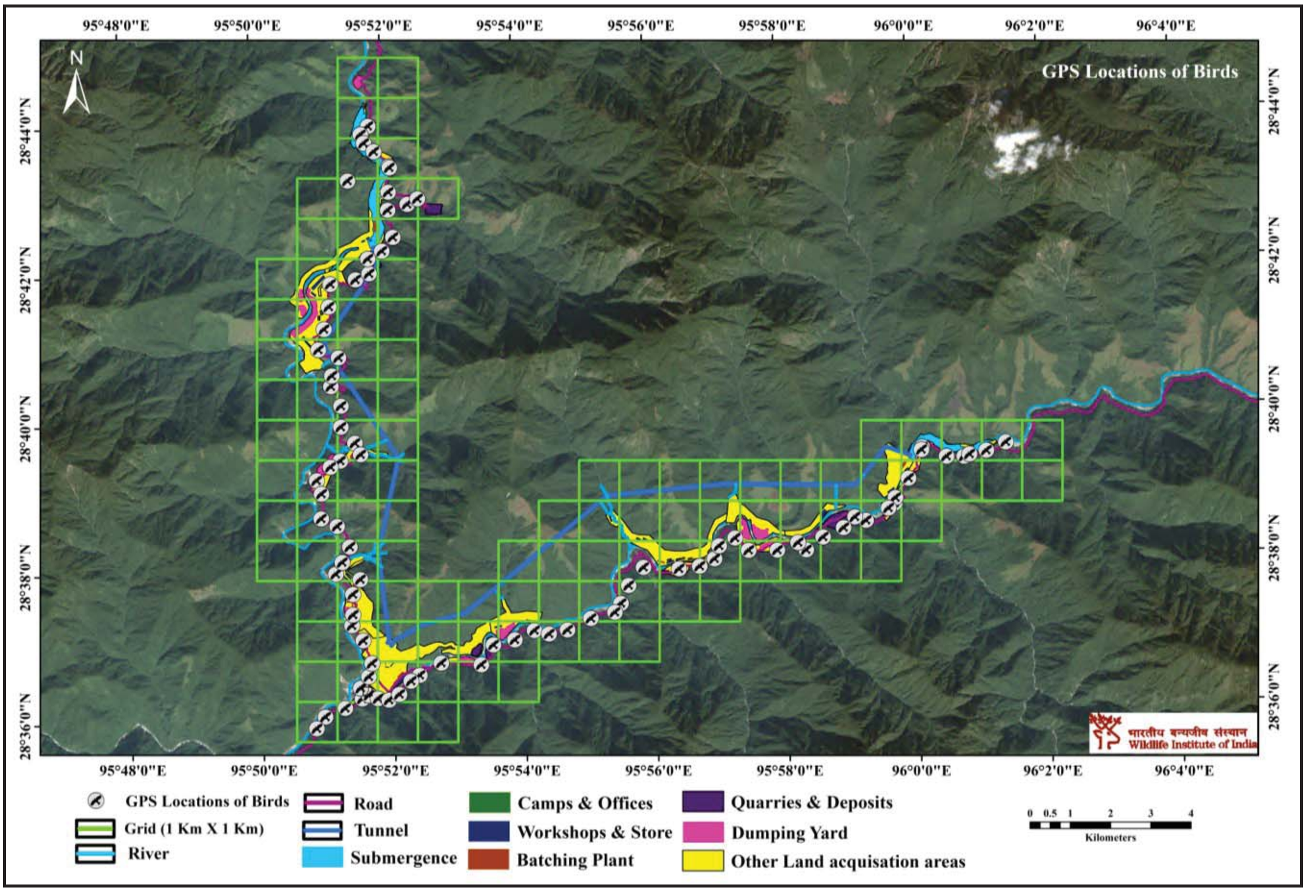
c) ***Opportunistic Sightings***: Opportunistic sighting involves recording bird species from different areas across the study site other than the regular survey time.

Sampling Details

A total of 89 Point count sites were surveyed and total distance of 50.5 km was covered via line transects. On the whole, using McKinnon's species richness method (McKinnon and Philip, 1993), 49 lists were enlisted (**Table 4.4**). The line transects/survey routes are shown in the map (**Map 4.4**).

Table 4.4: Sampling Details of Avifaunal Assessment

Sampling techniques	Dri River	Tangon River	Confluence	Study Area
Point Count Stations (#s)	43	42	4	89
Line Transects (km)	27	22	1.5	50.5
Species richness lists (#s)	22	23	4	49



Map 4.4: Map showing Avifauna Sampling Locations

Data analysis

The field data generated (**Plate 4.4**), using all three methods contributed in developing an avifauna checklist. Additionally, the data collected through point count surveys were used to generate information on species diversity, richness and composition.

Plate 4.4: Bird Assessments carried out as part of Etalin HEP Study

4.1.1.5 Mammals

Arunachal Pradesh is known for its rich biodiversity among any Indian state. About 65% of the total mammalian species of the country are found here (Anwaruddin 2003). Different forest types in the state are attributed to be the cause of rich diversity. Mammals play an important role in the ecosystem and ecosystem services. They are practically present in every ecosystem as members of the food chain and form pivotal links with other species in the ecosystems.

Sampling

Based on reconnaissance surveys (sign survey and secondary information from local communities) conducted along Tangon and Dri Rivers and at their confluence, the following sampling methodology was adopted:

a) **Camera trap method**: Camera trapping (Swann *et al.* 2010) was used for recording direct presence of mammals in all major proposed construction activity within the ZoI of project study area. This includes, land acquisition areas mainly for dam construction, quarry, dumping of the waste/muck, construction of batching plants, workshops and stores, offices, camps and colony etc. The elevation ranges of the areas and sites where camera trapping was carried out varied from 600m to 1800m. Camera traps were laid within 1x1 km grids at the closest permissible proximity (given the terrain constraints) to the site of project related activity. Some camera traps were also deployed outside but close to the impact zones (beyond tail end of Submergence of Tangon and Dri river, and below the confluence). Each camera trap was set for a period of 20-30 days.

   Camera traps deployed were Cuddeback E and G models. The Cuddeback E model is a white flash model, whereas the Cuddeback G model was an IR (Infrared) model. Both the models had a detection range of 100ft with a trigger speed of ¼ second. Both models were set to recover as "fast as possible (FAP)" after being triggered once.

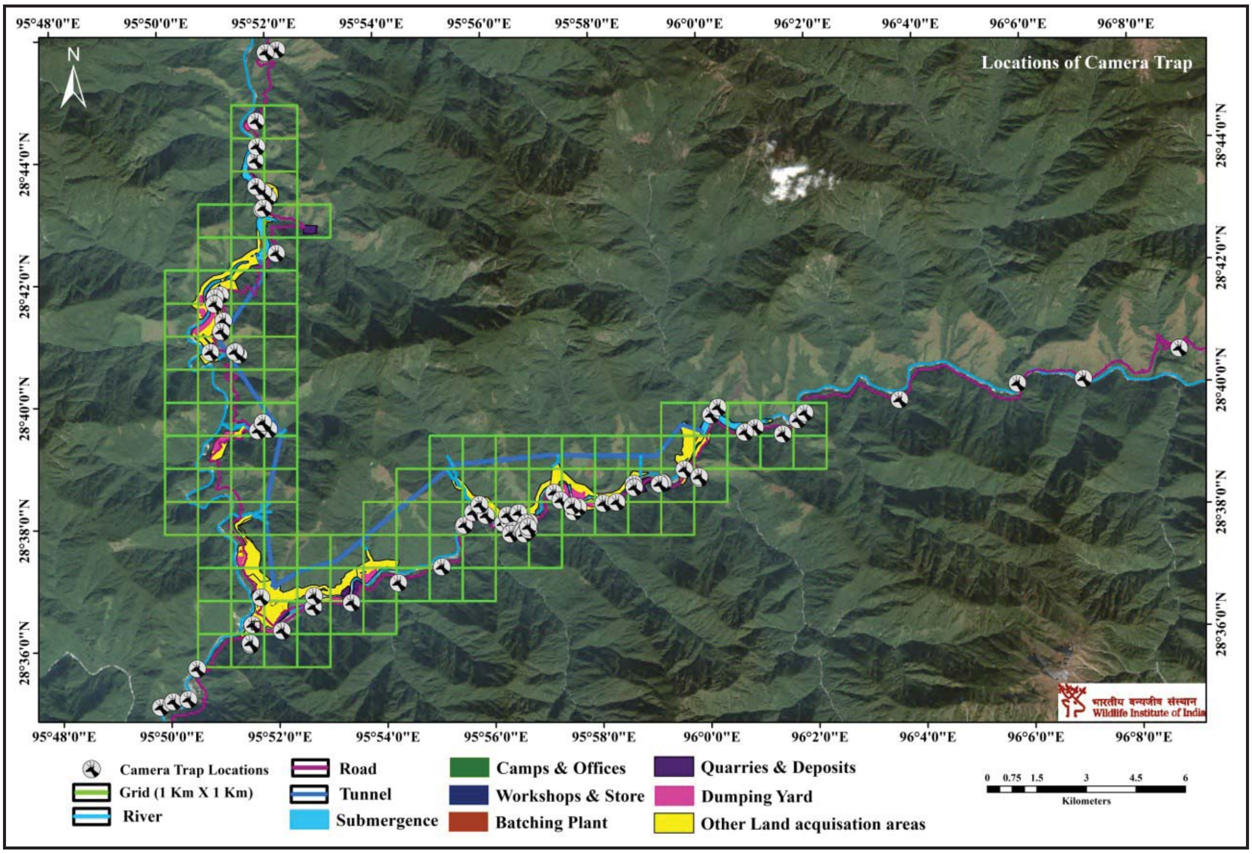
b) ***Random sampling***: Random opportunistic surveys were carried out based on information given by local people and sign surveys across the sites to assess the presence of mammals, particularly large cats

Sampling Details

Altogether, 78 camera traps were deployed over an area of 53 sq. k and a total of 1552 trap nights were sampled in the post monsoon/winter and pre-monsoon season (**Table 4.5 & Plate 4.5**). The locations of camera traps set for sampling mammals are shown in **Map 4.5**.

Table 4.5: Quantitative Details of Camera Trap Samplings

Sampling area	Grids covered	No. of cameras deployed	Total Camera trap nights/days
Dri River	16	28	430
Tangon River	29	46	981
Confluence	8	9	141
Total	53	78	1552



Map 4.5: Locations of Camera Traps laid for Sampling Mammals

Data analysis

The data generated using the two methods contributed in developing a mammal checklist. Additionally, the Relative Abundance Index (RAI), abundance of a given species across sites, for each species was also estimated. Collation of the data from the two long term research studies carried out/being carried out in (1) Lower Dibang valley and (2) Dibang Wildlife Sanctuary, were used to validate and establish the possible migratory routes for the large mammals beyond the study area

Plate 4.5: Setting up of Camera Traps for assessing Mammals in Etalin HEP Study Area

Camera Trap Installation along River bank

Camera Trap installation inside the Forest

4.1.2 Aquatic biodiversity

Fishes and benthic macroinvertebrates serve as ecological indicators for freshwater ecosystems, therefore, are vital taxonomic groups in any ecological assessment studies (Rajvanshi et al., 2012; Dudgeon, 2008; Magurran 2004, Hauer and Lamberti, 2007; Karr, 1981). In this study as well, distribution of fishes and benthic macroinvertebrates were assessed to ascertain the presence of RET species and aquatic biodiversity value of the study rivers. A reconnaissance survey was conducted along Tangon River, Dri River as well as Dibang river (beyond confluence point) to identify important sampling sites. Subsequently, sampling sites were chosen for detailed survey (**Table 4.6**) along these rivers and associated tributaries based on the impact zone locations and accessibility. The sampling was conducted (**Plate 4.6**) based on the following methodology:

a) ***Assessment of water quality parameters*:** The physico-chemical variables, namely dissolved oxygen (mg/l), pH, water temperature (^{0}C), specific conductance (µS/cm), total dissolved solid (ppm), electrical conductivity (µS/cm), were measured at each of the sampling sites using YSI water quality kit (YSI, Proportional Plus, USA) (**Table 4.6**).

b) ***Habitat Assessment*:** As a part of habitat assessment, certain key river meso-habitat characteristics, i.e. runs, riffles, pools and cascades, were measured in all 35 sampling sites. A sampling segment consist of approximately 100-150 m in length. All-important river characteristics were measured in each segment. Certain key variables related to channel morphology (Hauer and Lamberti, 2007; Johnson and Arunachalam, 2010) were also measured such as river width (m), depth (average), river flow (average), riparian cover (%) and substratum (proportion of rocks, boulders, cobbles, pebbles, sand, silt and woody vegetation if any). The river width was measured by using a range finder (LRF 400 Professionals). The average river flow was measured using flow probe (YSI, USA). Photographs were taken for each site for further habitat analysis.

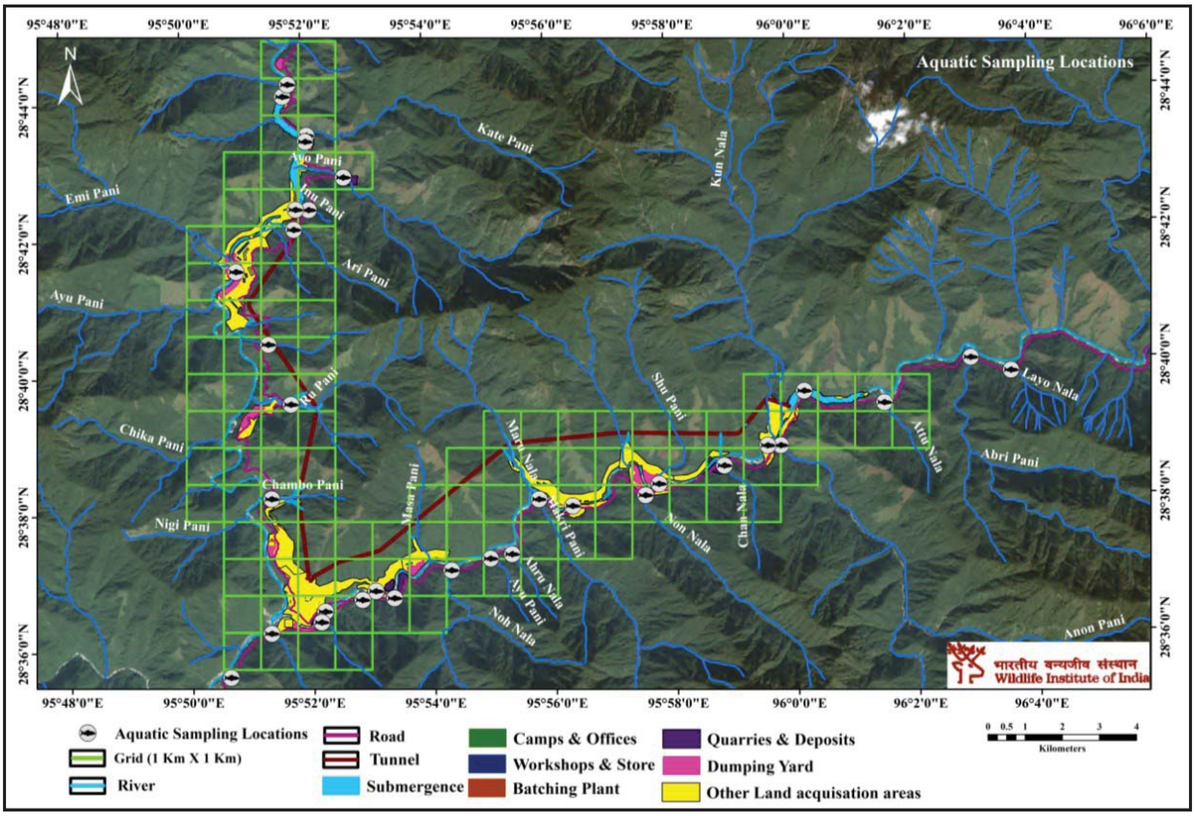
c) ***Assessment of Aquatic Biodiversity:***

- **Fish Sampling-** Fish sampling was done using different types of fishing gears such as cast net, gill net with different mesh size (0.5 × 0.5 mm, 1 cm × 1 cm, 1.5 cm × 1.5 cm), and employing local methods (bamboo traps etc). Fish sampling was done for approximately 60 minutes in each stream segment. Captured fishes were photographed in the field, identified and released back into the same location of capture.

  During post monsoon/winter (Feb-March 2018) and pre-monsoon season (April-May2018) fishes were sampled using local methods. "*Etho*" is the Mishmi name of a fishing gear in which the net is placed in between two bamboo poles. Locals generally keep few small to medium size stones below net so that it can withstand the strong flow in the stream. After placing the gear in the river, locals continuously throw stones around the net to disturb and dislodge fishes and capture them easily in the net. In each sub-basin, few seasonal streams were selected during monsoon season (May-June 2018) for fish sampling. Local methods, namely "*tha*" and "*ayuku*" (bamboo trap), were especially used for fish sampling during the monsoon season. These traps were laid overnight in select places along a stream. According to local knowledge, fishes that migrate especially during monsoon season are easily caught in such traps. These bamboo traps seem very efficient in capturing fishes such as *Tor* sp., *Neolissochilus* sp., etc.

During sampling, few individuals of unidentified fish specimens were collected and preserved in 70% ethyl alcohol for further identification. Certain complex groups of fishes were identified up to the genus level and then later confirmed with the Ichthyologist of Freshwater Fish Section of the Zoological Survey of India (ZSI) Kolkata, using identification guides (Nebeswar et al., 2007; McClelland, 1842; Hora, 1921; Sinha and Tamang, 2015; Thoni and Gurung, 2014).

- **Benthic invertebrates sampling-** Benthic invertebrate sampling was performed using drift net with fine mesh size (Trivedi and Goel, 1986). Collected benthic invertebrate samples were preserved in 70% Ethyl alcohol for further identification in the lab. Identification of the collected sample was done at family level in Zoological Survey of India (ZSI) Solan Himachal Pradesh, using the Olympus Stereo zoom Microscopes and using identification guides (Chandra et al., 2017). Approximately 0.5 m^2 area on ten randomly picked submerged pebbles, cobbles or gravels were scraped using scalpel.



Map 4.6: Locations of Aquatic Sampling Sites

Data analysis

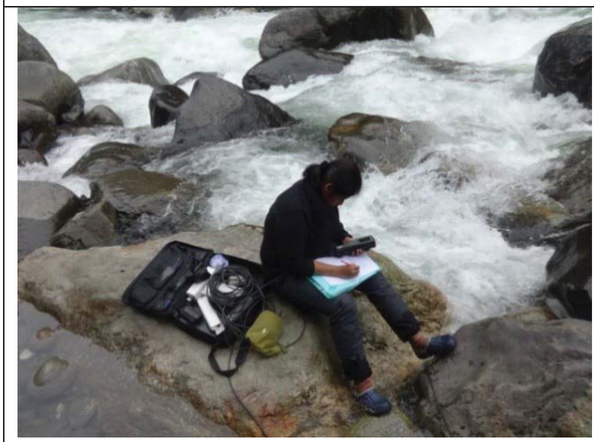
Collected data was processed and explored for further statistical analysis i.e. developing habitat suitability for indicator species and modelling for impact prediction. Approximately about 60 minutes were spent for fish sampling at each segment which was considered as a sampling effort. Data collected for all the sampling locations in post monsoon/winter, pre-monsoon and monsoon seasons, were pooled together to generate complete diversity profile (richness and relative abundance).

Fish species richness is the total number of fish species recorded in each stream segment. The number of individuals per species found in each segment was used to calculate relative abundance. Relative abundance data was later used to identify five dominant fish species found in each study sub-basin. Non-metric multi-dimensional scaling (NMDS) method was used to calculate fish community composition. All the data was analysed using R statistical software ver. 3.4.1 (R Core Development Team, 2018).

Table 4.6. Sampling Sites for water quality parameters (WQ), fish (F) and macroinvertebrates (MI) were assessed across seasons.

Season	Dri River	Tangon River	Confluence	Total
Winter (WQ, F, MI)	12	13	2	27
Pre- monsoon (WQ, F, MI)	12	13	2	27
Monsoon (WQ, F)	9	5	0	14

Plate 4.6: Assessment of Aquatic Biodiversity



Water Quality Assessment

Benthic Insect Sampling

Fish Sampling using Cast net

Fish sampling using local method during monsoon season (Etho)

Evaluation of EHEP Impacts on Terrestrial Biodiversity

a) *Assessing terrestrial biodiversity values within EHEP area*

For this study, a set of criteria were identified to assess terrestrial biodiversity values within each sampled grid (**Table 4.7**). These criteria capture the importance of the ecological/biological characteristics of these areas, especially in terms rarity, vulnerability or irreplaceability of their values.

Table 4.7: Criteria and Description considered for Evaluation of Impacts on RET and Endemic Species

No.	Criteria	Description
1.	RET (Rare, Endangered and Threatened) Species, as per IUCN and other global/national criteria	Percentage of RET species present in the sampled grid $\left(\frac{No.\ of\ RET\ species\ in\ a\ grid \times 100}{Total\ no.of\ RET\ species\ in\ the\ study\ area}\right)$
2.	Endemic Species	Percentage of endemic species present in the sampled grid

Calculation of biodiversity values: weighted scoring

Scores ranging from 1 to 4 were assigned to each criterion with 1 and 4 representing the lowest and highest values respectively. Each criterion was given an equal weight (0.125) so that the maximum cumulative score would amount to one. In order to obtain an overall value, a linear additive value function (Eq. (1)) was used to combine individual criterion:

$$BV_j = \sum_{i=1}^{n} w_i s_i \qquad (1)$$

Where, BV_j is the biodiversity value in a sampled grid j, n is the total number of criteria (two in this case), w_i and s_i is the weight and score for each criterion i respectively. Subsequently, the biodiversity values falling in classes of 0-0.25, 0.26-0.50, 0.51-0.75 and 0.76-1 were categorised in four categories namely low (L), medium (M), high (H) and very high (VH), respectively.

b) *Assessing impact potential of EHEP with respect to terrestrial biodiversity*

In the current study, the specific impact indicators were used (**Table 4.8**) based on their potential to cause definite changes in characteristics of receptors.

Table 4.8: Criteria and Description for Impact Indicators

S. No.	Criterion	Description	Weights
1.	Dam	Presence/absence of a dam in the sampled grid	0.05
2.	Land acquired for associated activities (submergence area, muck disposal, quarrying, construction of buildings etc.)	Percentage land acquired within each grid $\left(\frac{Area\ of\ land\ acquired\ (in\ sq.km) \times 100}{Area\ of\ grid\ (= 1\ sq.km)}\right)$	0.2

In the case of criterion 1, depending on the presence or absence of a particular impact criterion, a score of zero (absence) or four (presence) was assigned. For criterion 2, the percentage values falling in classes of 0, >0-0.25, 0.26-0.50, 0.51-0.75 and 0.76-1 were assigned scores from 0 to 4, in that order.

These criteria were assigned different weights (**Table 4.8**), higher weights were assigned to those impact sources which can have high, permanent, irreversible, or impacts over large spatial or temporal scales. In this case as well, the maximum attainable score was one.

The impact score, referred to as Impact Potential (IP_j), in a sampled grid j, was calculated using equation 2 (similar to equation 1):

$$IP_j = \sum_{i=1}^{n} w_i s_i \qquad (2)$$

After the estimation of impact potential values, the values falling in classes of 0-0.25, 0.26-0.50, 0.51-0.75 and 0.76-1 were categorised in four categories namely low (L), medium (M), high (H) and very high (VH), respectively.

c) *Assessing Impact Significance Values*

The significance of impacts for terrestrial biodiversity was calculated similar to that done for aquatic biodiversity. The following matrix given in table **4.9** was used.

Table 4.9: Biodiversity Value and Impact Potential Matrix

Biodiversity Value	**Impact Potential**			
	Very high	**High**	**Medium**	**Low**
Very high	Very high	Very high	High	Medium
High	Very high	High	Medium	Low
Medium	High	Medium	Medium	Low
Low	Medium	Low	Low	Low

Evaluation of EHEP Impacts on Aquatic Biodiversity

Assessing biodiversity values and impact significance: Use of criteria

Spatial planning and conservation efforts centres around balancing economic development (e.g., hydropower generation), biodiversity conservation goals and sustained flow of ecosystem services. This calls for evolving a structured, scientifically defensible and effective framework for protecting biodiversity (Regan et.al. 2007). In order to do so, efforts are required to prioritize between geographical areas, and components of biodiversity and the threats by assessing and assigning biodiversity values to the sites (Gilman et al., 2011). A variety of criteria-based assessments (Rosset et al., 2013; Stewart, 2011) specifying ecological, biological, and socio-economic properties have been used to identify areas of relatively high biodiversity value or key biodiversity areas (KBAs) and/or to evaluate impact significance either quantitatively or qualitatively. Such assessments have been used not only to identify areas of local importance but also to identify sites for improving protected networks aimed at maintenance of entire ecosystems at a global scale (Gilman et al., 2011; Regan et al., 2007).

Prediction of impacts and their and their significance is a vital step in ecological impact assessment. The significance of an impact is widely accepted to be a function of the magnitude of the impact (i.e. aspects of development likely to bring change) and the sensitivity of the receptor (i.e. components of the site sensitive to such change). Determination of impact significance gives an indication about what is desirable or acceptable and the degree of importance (Lawrence, 2007a). The key components of impact significance determination procedures are thresholds (a clearly defined performance level that explicitly establishes significance) and criteria. It is crucial that these thresholds and criteria are clearly defined, unambiguous, readily applicable, fully substantiated and relevant to the local and regional context (Lawrence, 2007b).

Systems of scoring and weighting are used frequently in ecological assessments to measure and adjust criteria and impacts. Scoring enables assigning numerical thresholds to evaluation criteria. Weighting enables prioritizing among criteria (Gilman et al., 2011). Weighted scoring or Simple Additive Weighting method is one of most widely used methods in multi-criteria analysis for decision making as well as for biodiversity risk assessment (ICEM, 2007; SEIA 2008; Dodgson et al., 2009). In this study, biodiversity values and significance of hydropower impacts on biodiversity were assessed using criteria, thresholds and weighted scoring.

a) Assessing biodiversity values within EHEP area

For this study, a set of criteria was identified to assess the biodiversity values within each sampled grid (**Table 4.10**). These criteria capture the importance of the ecological/biological characteristics of the sampled areas, especially in terms of rarity, vulnerability or irreplaceability of their values.

Table 4.10: Criteria for assessing Aquatic Biodiversity Values within the Study Area

No.	Criteria	Description
1.	RET (Rare, Endangered and Threatened) Species, as per IUCN and the Indian Wildlife Protection Act (IWPA, 1972)	Percentage of RET species present in the sampled grid $\frac{No.\ of\ RET\ species\ in\ a\ grid \times 100}{(Total\ no.of\ RET\ species\ in\ the\ study\ area)}$
2.	Endemic Species	Percentage of endemic species present in the sampled grid
3.	Migratory species (long-distance)	Percentage of migratory species present in the sampled grid.
4.	Breeding/Congregation sites	Presence/absence of breeding sites and congregation opportunities for fish species
5.	Species Richness	Relative species richness (%) in the sampled grid.

Calculation of biodiversity values: weighted scoring

Scores ranging from 1 to 4 were assigned to each criterion with 1 and 4 representing the lowest and highest values respectively. In the situation where, binary responses were obtained (e.g. presence/absence of breeding/congregation sites), the absence of that particular value was assigned a score of 1, while presence was assigned a score of 4. This scoring system allowed for standardization of the values generated for individual indicators.

Each criterion was given an equal weight (0.05) so that the maximum cumulative score would amount to one. In order to obtain an overall value, a linear additive value function (Eq. (1)) was used to combine individual criterion:

$$BV_j = \sum_{i=1}^{n} w_i s_i \qquad (1)$$

Where, BV_j is the biodiversity value in a sampled grid j, n is the total number of criteria (five in this case), w_i and s_i is the weight and score for each criterion i respectively. Subsequently, the biodiversity values falling in classes of 0-0.25, 0.26-0.50, 0.51-0.75 and 0.76-1 were categorised in four categories namely low (L), medium (M), high (H) and very high (VH), respectively.

b) Assessing impact potential of EHEP with respect to Aquatic Biodiversity

In the current study, the specific impact indicators were used (**Table 4.11**) based on their potential to cause definite changes in characteristics of receptors.

Table 4.11: Criteria for Impact Indicators

No.	Criterion	Description	Weights
1.	Dam	Presence/absence of a dam in the sampled grid	0.10
2.	Submergence area	Presence/absence of submergence area in the sampled grid	0.76
3.	Muck disposal site	Presence/absence of a muck disposal site in the sampled grid	0.05
4.	Quarrying site	Presence/absence of a quarrying site in the sampled grid	0.05
5.	Tributary inflow	Presence/absence of a tributary confluence in the sampled grid	0.04

Depending on the presence or absence of a particular impact criterion, a score of zero (absence) or one (presence) was assigned. The only exception was the criterion "tributary inflow" where the presence of a confluence was assigned a score of zero and absence was assigned the score of one, since a tributary discharging into the main dammed river has the potential of reducing the impacts of other impact sources. In other words, the absence of an inflowing tributary was considered as an impact source.

These criteria were assigned different weights (**Table 4.11**), higher weights were assigned to those impact sources which could induce high, permanent, irreversible impacts over large spatial or temporal scales. The maximum possible impact value score was one.

Since the impacts within a river system are cumulative in nature, a different methodology for the calculation of cumulative impact score was adopted. For the calculation, it was assumed that the impacts are additive and that 70% of the impacts within adjacent upstream grid are retained in the grid under evaluation. Firstly, impact scores were calculated for all relevant grids based on impact sources within the grid, i.e. excluding upstream impacts. This impact score, referred to as Exclusive Impact (EI_j) value in a sampled grid j, was calculated using equation 1:

$$EI_j = \sum_{i=1}^{n} w_i s_i \qquad (2)$$

The final impact score inclusive of upstream impacts in a grid j, referred to as Impact Potential (IP_j), was calculated by adding 70% of the exclusive impact value of the previous grid (EI_{j-1}) to the exclusive impact value of the current grid (EI_j):

$$IP_j = EI_j + 0.7\ (EI_{j-1}) \qquad (3)$$

The impact potential values were calculated using equation (3) in the grids downstream to the proposed dams. Equation (2) was used to calculate impact potential values for grids upstream to the dams and those containing tributaries of Dri/Tangon river.

After the estimation of impact potential values, the values falling in classes of 0-0.25, 0.26-0.50, 0.51-0.75 and 0.76-1 were categorised in four categories namely low (L), medium (M), high (H) and very high (VH), respectively.

c) Assessing Impact Significance Values

The significance of an impact is widely accepted to be a function of the magnitude of the impact (IP) and the sensitivity of the receptor (BV). As seen in previous sections, the quantitative scores were ultimately converted into qualitative score (L, M, H, VH) for both impacts sources and receptors. These categorized impact potential values and biodiversity values were then interacted in the form of a matrix to give the significance of impacts. The key followed for arriving at interaction values (modified from ICEM, 2007) is given in the table (**Table 4.12**).

Table 4.12: Impact Evaluation Matrix

Biodiversity Value	**Impact Potential**			
	Very high	**High**	**Medium**	**Low**
Very high	Very high	Very high	High	Medium
High	Very high	High	Medium	Low
Medium	High	Medium	Medium	Low
Low	Medium	Low	Low	Low

4.1.3 Socio-cultural Status

Survey methodology

a) ***Identification of Project Affected Villages (PAVs):*** Demographic profiles of the district were extracted from Primary Census Abstract, 2011 (National Census, govt. of India, 2011) and list of Project Affected Villages (PAVs) along with list of Project Affected Families (PAFs) were extracted as secondary data (Social Impact Assessment and R & R Plan of EHEP Project, January 2015). A total of 18 villages were identified as PAVs. From this list of PAVs, the number of PAFs for both Dri and Tangon basins of the project area, were identified. The PAVs were further differentiated based on direct (land acquisition) and indirect impacts (other project related activities) of EHEP on the people.

b) ***Semi-structured Questionnaire Survey:*** A standard questionnaire was developed for the collection of primary data from the field. The questionnaire for the survey was pre-tested (trial runs) to assess the appropriateness of the questions. A semi-structured questionnaire (**Annexure 4.1**) with both open ended and close ended questions was used for the survey (Bernard 2017; Mitra et al., 2017; Nash et al., 2016; Nyariki, 2009).

c) ***Survey Procedure:*** Primary strategy for identifying respondents, for conducting household surveys, involved selecting people randomly to interview by walking through each village. As each village was relatively small, this approach led to traversing the entire village. Children and teenagers below the age of 15 were not interviewed. One respondent per household was interviewed, usually head of the family. Respondent of both genders were interviewed and if anyone reported having an occupation, then they were also interviewed (**Plate 4.7**).

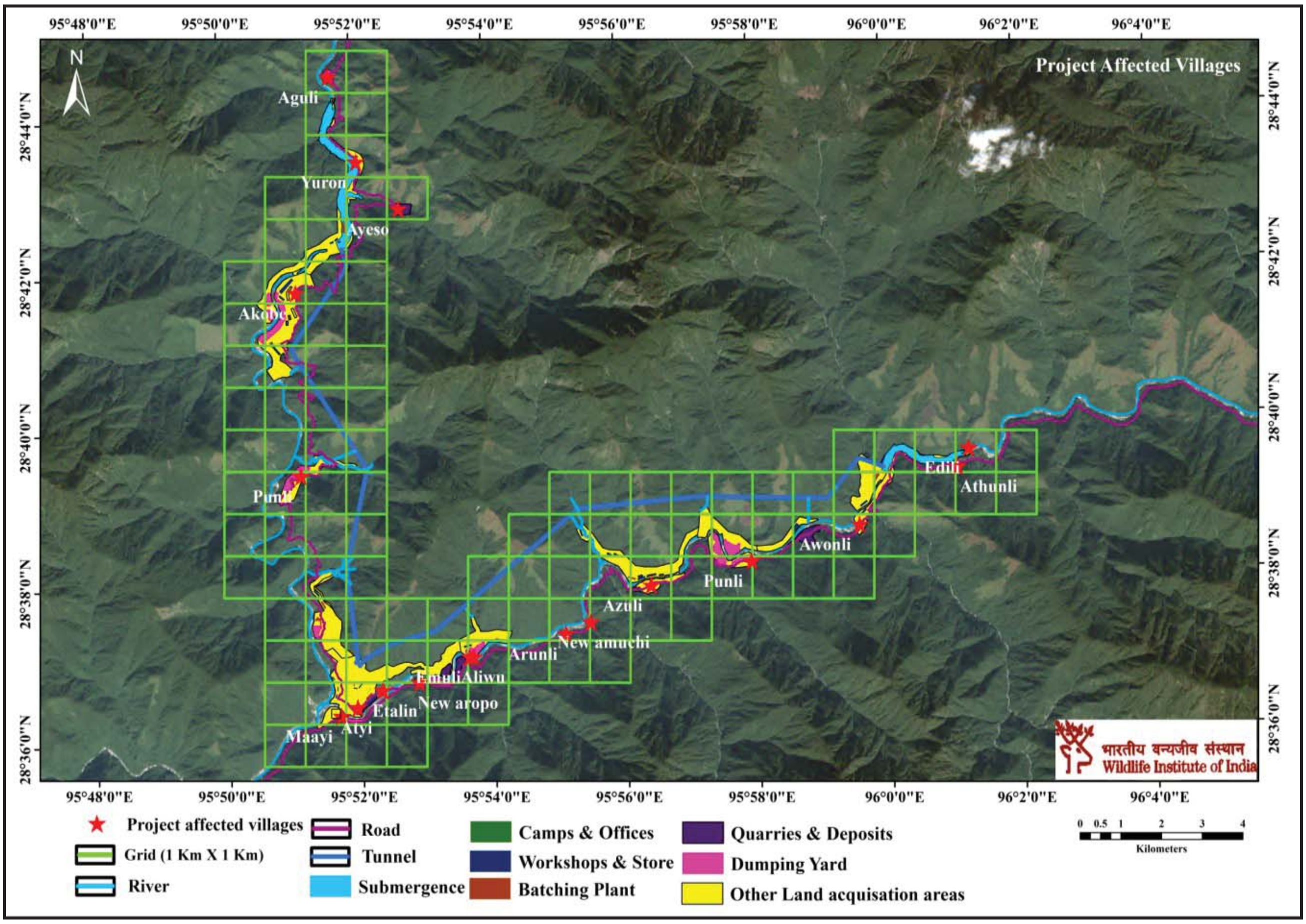
Plate 4.7: Interviewing individuals from local Ethnic Community, in different villages of the Study Area

This survey included some demographic information on gender, age, religion, tribe, clan, education level, length of residency, household profile (type of family), type of house, source of household income, drinking water facilities, use of fuel, crop cultivation and livestock, knowledge about medicinal plants, cultural values associated with flora and fauna (totems and taboos). Knowledge about wildlife present in and around villages was ascertained using field guide books. Pictures of mammal, birds and snakes were shown to respondents for easy identification and to gather information on their local names. Later on, fodder species, wild edible species of plants, medicinal plants used by them were also photo documented. Perception of people towards EHEP, in terms of the loss and gain considering their economy and culture, was also recorded.

As the villagers were wary of questionnaire forms used for conducting interviews, hence information was noted down in field notebook, sometimes even recorded with Dictaphone with their permission and transcribed later.

d) Sampling Details - Household Survey

Total 179 households were interviewed in the 22 villages surveyed (**Map 4.7**). Kaduli and Matuli villages were surveyed as residents of Ayeso and Apayee villages, as they had settled there for approximately last 20 to 30 years. Imuli village was also surveyed on Dri side as resident of Ayeso village were settled there. List of villages surveyed is given below (**Tables 4.13 & 4.14**).



Map 4.7: Locations of the Project Affected Villages (PAV) in the Etalin HEP Study Area

Table 4.13: Details on Project Affected Villages and Families (PAV/PAF) surveyed in Anini Circle/ Dri river

S.No.	Anini Circle/Dri Basin		
	PAVs	**PAF**	**PAFs Surveyed**
1.	Punli	31	17
2.	Ayeso	6	1
3.	Akobe	23	8
4.	Yuron	10	3
5.	Apayee	11	0
6.	Aguli	10	4
7.	Matuli	0	8
8.	Kaduli	0	8
9.	Imuli	0	2
	Total	**91**	**51**

PAV – Project Affected Villages, PAF – Project Affected Families

Table 4.14: Details on Project Affected Villages and Families (PAV/PAF) surveyed in Etalin Circle / Tangon Basin

S.No.	Etalin Circle/Tangon Basin		
	PAVs	**PAF**	**PAFs Surveyed**
1.	Etalin HQ	42	34
2.	Etalin Bridge Point	62	34
3.	New Aropo	16	12
4.	Emuli	7	0
5.	Punli	5	3
6.	Aruli	19	12
7.	Athunli & Edili	25	13
8.	Aunli	10	6
9.	Apunli	4	0
10.	Aliwu	3	1
11.	Atyi	8	4
12	Azuli	2	2
13	Amuchi	0	4
14	Maayi	0	3
	Total	**203**	**128**

Note: Total 294 PAFs in 18 PAV's were identified for Social Impact Assessment and R & R Plan of EHEP Project, January, 2015. No PAF's dwell in the following PAV's viz. Apayee, Apunli, Emuli. They dwell elsewhere and survey of these PAFs was conducted in other villages. In addition to these, many PAFS do not stay in PAV's as they have their permanent / temporary residence in Anini, Roing, Tezu, Itanagar etc. So, during the time of survey they were unavailable.

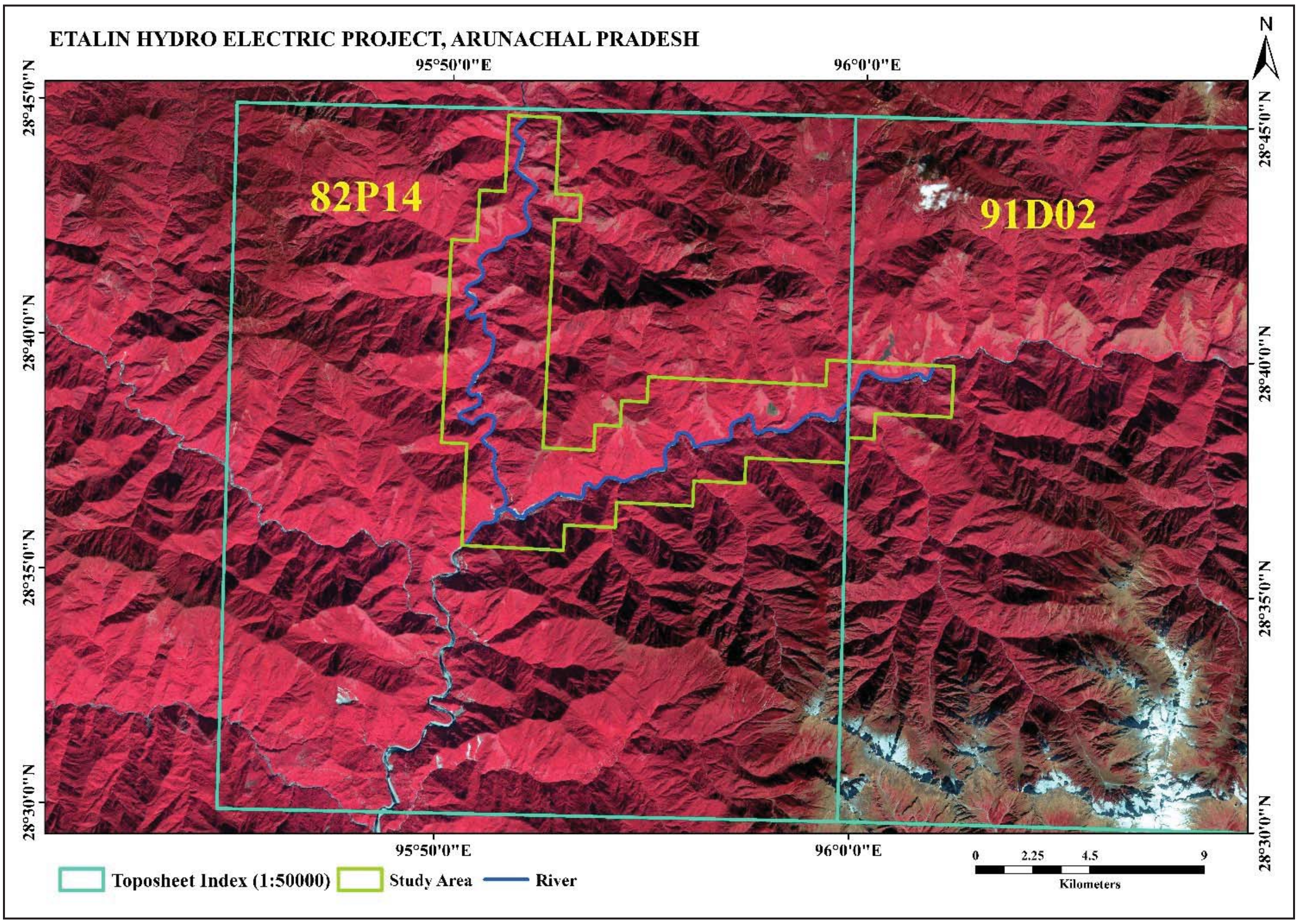
e) ***Analytical Methods:*** The primary data collected from the household survey will be used to understand the following aspects:

- Socio economic status of the PAV in the form of quality of life and sources of income generation
- Cultural values attached to biodiversity of the study area and kind of resources they depend on to understand the magnitude of resource use.
- Impacts of project related activities on both economy and culture and their perceptions on the EHEP.
- Structuring the types of management plans to be implemented, so as to minimise the biotic pressures (people & project) on the biodiversity of the project area under CSR activities.

4.4 Geospatial database

The GIS database of the Etalin HEP study area was generated by collecting several ground truth data and the data that were acquired from satellite imagery. The landscape features like road, settlements and plantations were generated from the ground truth data collected. The topographic sheets (82P14, 91D02) was used as a reference to affirm the data generated. **Map 4.8**, shows the toposheet index of the study area. Various thematic layers prepared based on the above were as follows,

- Study area / Impact zone
- Vegetation types and land use/land cover (LULC)
- Sampling locations
- Threatened species locations
- Tiger presence/absence map
- Land acquisition area (Source – Etalin HEP)
- 3D view of the study area
- Project affected villages
- Contour
- Slope
- Aspect



Map 4.8: Toposheet Index of the Etalin HEP Study Area

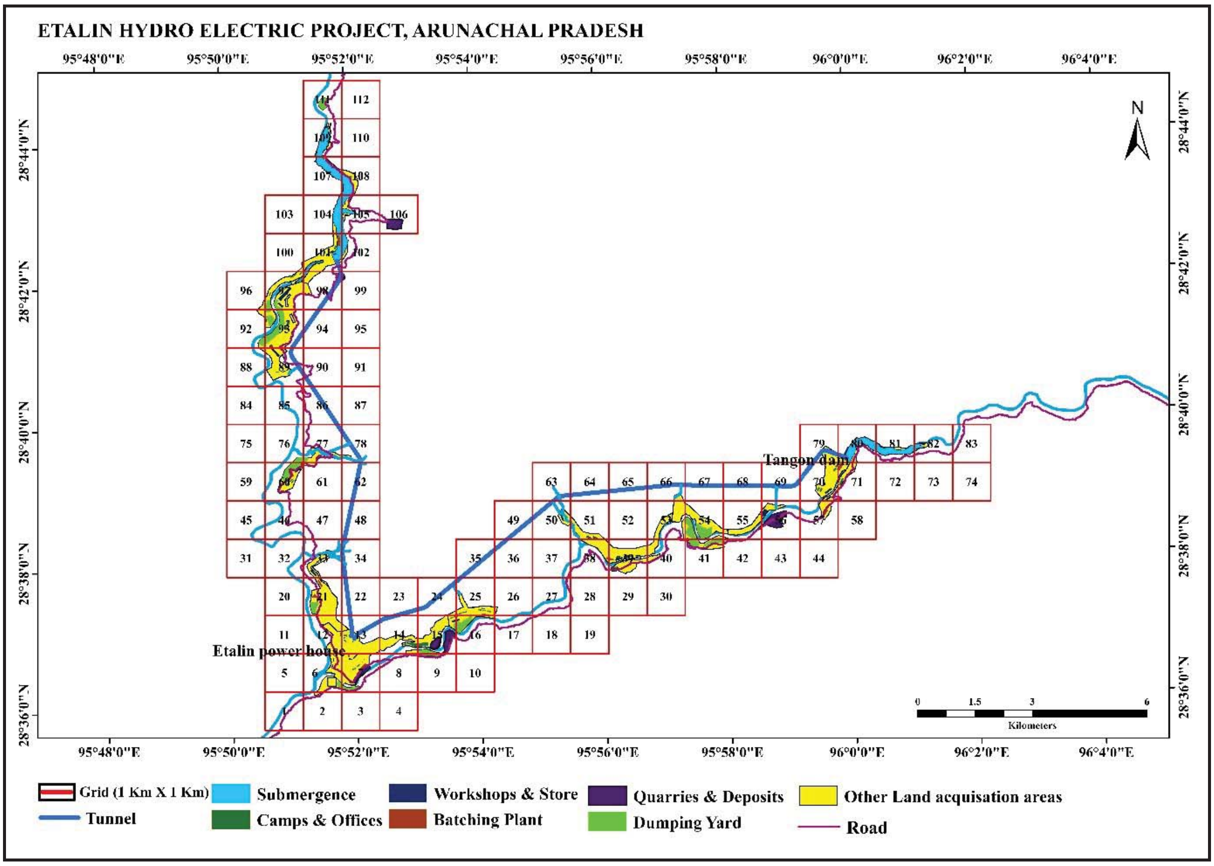
The GIS & RS techniques were used to map the forest types mainly to facilitate and support in the assessment of all the other study components that include vegetation, entomofauna, herpetofauna, birds, mammals, fishes, benthic invertebrates and local communities related biodiversity issues, as part of collating the baseline biodiversity values of the Etalin HEP project. Geospatial database for the study was developed through the following major objectives.

- Delineation of the ZoI (study area) that comprises the proposed dam construction site and sites identified for other related operation activities (land-acquisition areas), and geophysical and biological attributes (Land Use and Land Cover).
- Preparation of different first level thematic maps, namely contour map, drainage map, vegetation type map (Land Use and Land Cover) and maps containing sampling locations, in order to facilitate surveys for all study components.
- Preparation of biodiversity attribute maps (species richness/abundance /diversity/RET species) of different floral, faunal and social components studied.
- Identification and preparation of critical habitat and grid-based biodiversity value, impact potential and impact significance maps for terrestrial and aquatic components.

4.4.1 Methodology

4.4.1.1 Demarcation of the Study area / Delineation of Zones of Impact (ZOI)

- 1km x 1km grids were generated and overlaid over the proposed project land acquisition areas.
- All grids that were overlapping with the land acquisition areas, river valley and the grids adjacent to them were selected for delineating the study area *viz-a-viz* the impact zones.
- This covered all the land acquisition areas of the project including quarries & deposits, dumping yards, submergence, batching plants, camps, residential colony and offices, tunnels and other land acquisition areas (**Map 4.9**).



Map 4.9: Land Acquisition Areas with Gridded Etalin HEP Study Area Boundary

4.4.1.2 Satellite data used

- Sentinel-2A with 10 m resolution and Landsat 8 satellite data with a spatial resolution of 30m acquired on the month of November 2017 used for this study as the cloud cover in it was low.
- Cartosat DEM (Digital Elevation Model) data with 30m resolution was used for contour and Land use and land cover mapping.

4.4.1.3 Software used

ERDAS IMAGINE 2016 and ARCGIS 10.5.1 were used to prepare different thematic maps. Google earth was used for ground truthing.

4.4.1.4 Methodology adopted for the Vegetation Types and Land Use / Land Cover Mapping.

We attempted knowledge-based classification techniques with satellite images having different spatial resolutions i.e., Sentinel-2A data with 10 m resolution and Landsat 8 with 30 m resolution. Initially the Sentinel -2A was used for deriving Normalised Difference Vegetation Index (NDVI),

$$NDVI = (NIR - RED)/(NIR + RED)$$

Then it was conjugated with the Cartosat DEM and unsupervised classification is performed with 500 clusters. Quite large amount of miss classification of the pixels in resultant image was experienced. And then Landsat 8 satellite data is performed with the Modified Soil Adjusted Vegetation Index – 2 (MSAVI - 2), $MSAVI\ 2 = \left(2 * NIR + 1 - SQRT\left((2 * NIR + 1)^2 - 8 * (NIR - RED)\right)\right)/2$

Followed by the MSAVI 2, unsupervised (Roy et al., 1993; Joseph et al., 2018; **Figure 4.1**) is performed for the resultant image with 100 clusters gave a better classification output. As the study area falls under the category of climax and mixed forests it was hard to carry out intensive classification. Knowledge based classification technique is carried out for the vegetation types and LULC classification.

The Vegetation type and LULC are broad classification of vegetation types and physiographic features, which are categorized into Tropical, Subtropical, Secondary evergreen forest (that mainly comprised bamboo, wild banana and broad-leaved species), Grassland, Settlement, Scrub and River. The forest types were categorized according to various properties like spectral signature, texture, tone and altitude. The various ground truth locations of settlements, roads and the other landscape features were collected to refine the classified satellite image.

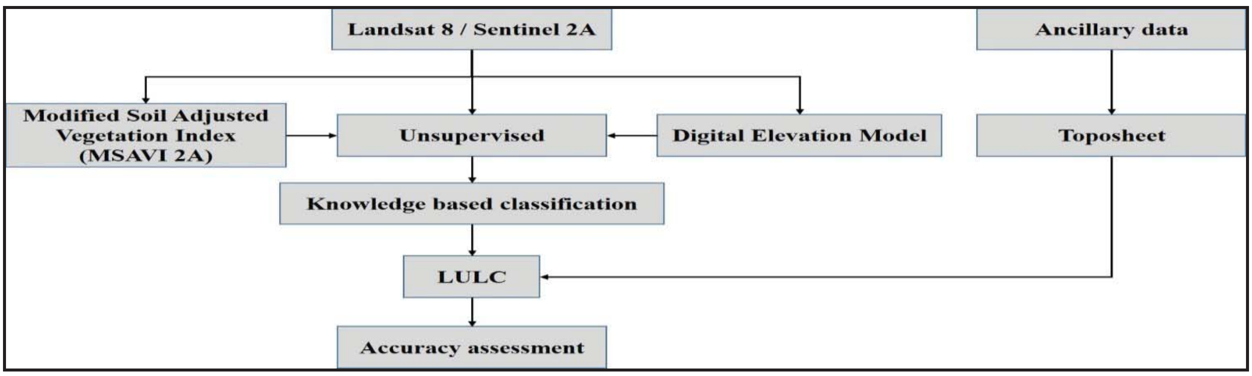


Figure 4.1: Flow Chart showing the Methodology adopted for Land Use and Land Cover (LULC) Classification

Chapter 5: Assessment of Biodiversity values in the Study Area

5.1 Habitat Status – Mapping of Vegetation types and Land Use / Land Cover and other features

5.1.1 Vegetation types and Land Use / Land Cover

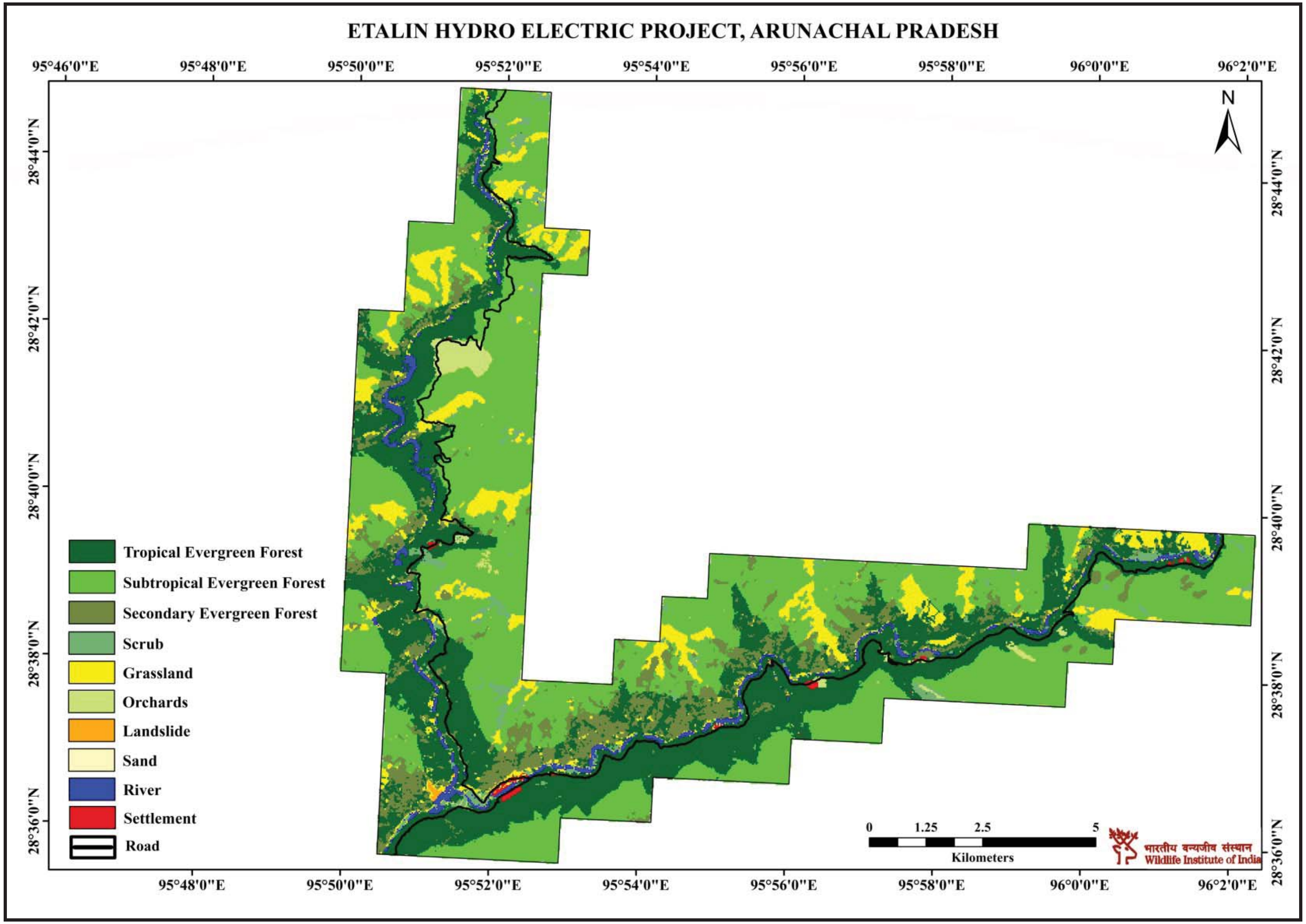
A detailed vegetation types and LULC map was produced using knowledge based classification technique i.e. Modified Soil Adjusted Vegetative Index 2 (MSAVI 2). The forest types based on the previous research work carried out in the northeast region by Rao and Panigrahi (1961), Champion and Seth (1968), Kaul and Haridasan (1987), are categorized according to tone, spectral signature and altitude. The vegetation and LULC mapping are broad classification of vegetation types and physiographic features. The vegetation types were categorized into Tropical evergreen, Subtropical evergreen, Secondary evergreen forest (that mainly comprised bamboo, wild banana and broad-leaved species), Grassland, Settlement, Scrub and River.

The accuracy assessment of vegetation types and land use/landcover map was performed by calculating the Kappa coefficient and overall accuracy through the preparation of confusion matrix. Based on this the overall accuracy of the vegetation types and land use/landcover mapping were found to be 90% and the Kappa coefficient is 84%.

The vegetation and land use / land cover mapping of the Etalin HEP study area showed that Subtropical Evergreen Forest was the most dominant category, forming 44.4% of the total study area (112 km^2). Tropical Evergreen Forest (30.4%) was the second most commonly found vegetation or LULC type in the study area followed by Secondary Evergreen Forest (9.9%) and Grasslands (8.3%). Scrub was minimal, while other categories were very less, thus showing that the study area is almost fully covered with forest (**Table 5.1 & Map 5.1**).

Table 5.1: Extent (km^2) and Relative % of different Vegetation and Land Use Land Cover (LULC) types in Etalin HEP Study Area

LULC	AREA (Sq. km)	Percentage (%)
Subtropical evergreen forest	49.75	44.42
Tropical evergreen forest	34.05	30.40
Secondary evergreen forest	11.11	9.92
Scrub	3.88	3.47
Grassland	9.25	8.25
Orchards	1.33	1.19
Landslide	0.03	0.032
Sand/River bed	0.19	0.17
Water channel/River	2.03	1.82
Settlements	0.33	0.29
Total	**112**	**100**

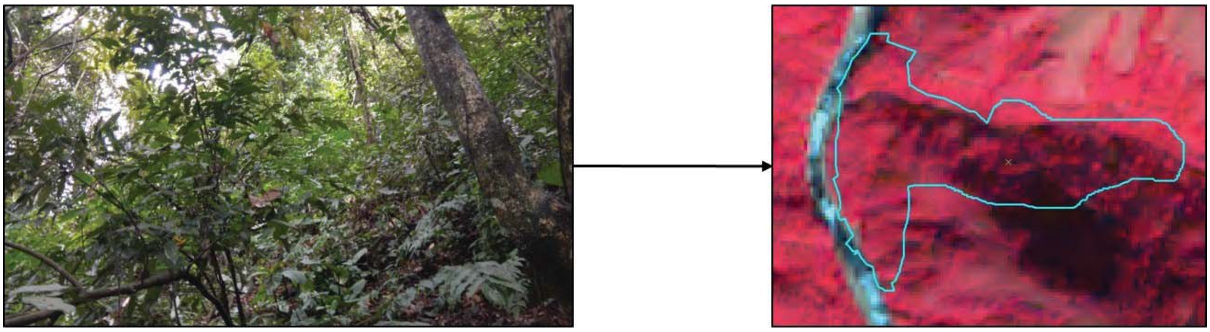


Map 5.1: Vegetation Types and Land Use Land Cover of the Etalin HEP Study Area

5.1.1.1 Description of different Vegetation and Land Use/Land Cover types

Tropical Evergreen Forest

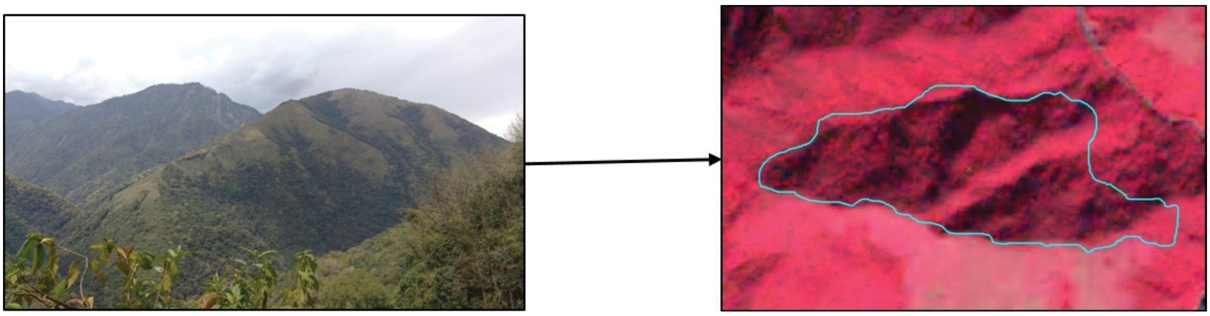
Tropical evergreen forest extends up to 1200mts where, mostly it spreads along the river valley and foothills with a dense canopy, evergreen forest. *Calamus erectus*, *Terminalia myriocarpa, Tetrameles nudiflora, Aerides multiflora Roxb.* were the common associates found in this type of forest. The reflectance of the tropical forest is varied from dark red to pink in colour depending on the aspect.



Tropical forest on the ground and delineation in satellite image

Subtropical Evergreen Forest

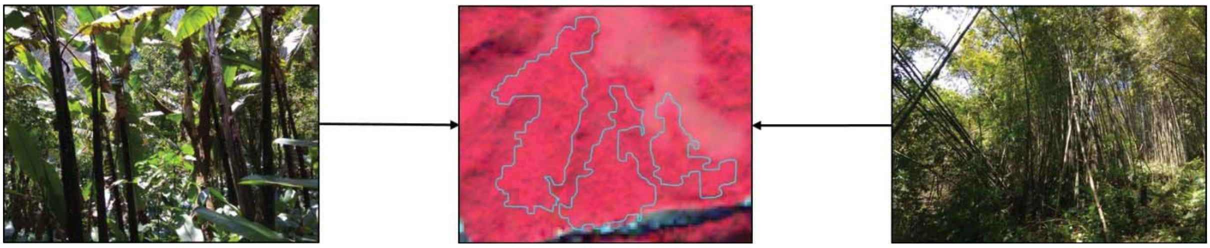
The Subtropical evergreen forest occurs between 1200m to 1800m, which are evergreen, dense in nature and rich in species diversity. These were similar to the tropical forest region in the satellite image as altitude and the association played a vital role in classifying these forest types. They appeared as bright red to pink in colour on the satellite image.



Subtropical Forest on the ground and delineation in satellite image

Secondary Evergreen Forest

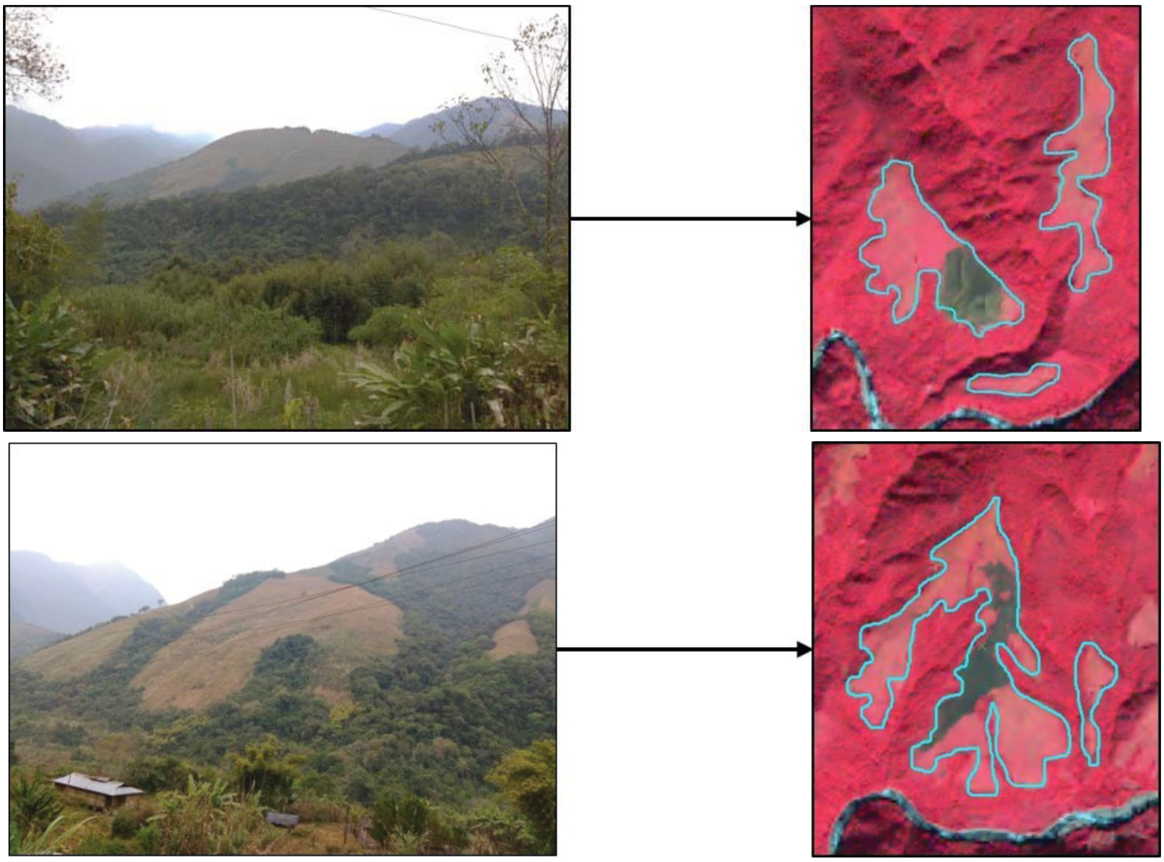
The satellite data used for the study was acquired for the month of November, which is a peak winter, when the leaves were very moist and showed a specular texture in the satellite image. This specular texture is used for the delineation of Secondary Evergreen Forests. Secondary evergreen forest occurs up to the altitude of 3000m, which are influenced by different factors both biotic and abiotic. Bamboo, wild banana and broad leaves were the predominant species found in this type of forest. Degraded forest, which has poor species diversity with subservient trees, also falls under the Secondary evergreen forest category. They appear in shades of pink from bright to light on the satellite imagery.



Secondary Evergreen Forest on the ground and delineation in satellite image

Scrub and Grassland

The scrub and grasslands areas are interpreted easily with their unique smooth texture and by the light pink colour and some of the burnt area appear in dark grey tint in the FCC image, which helps to differentiate with all other features. The grasslands are surrounded by the scrubs, which are also easily interpreted in the satellite imagery



. **Scrub and Grassland on the ground and delineation in satellite image**

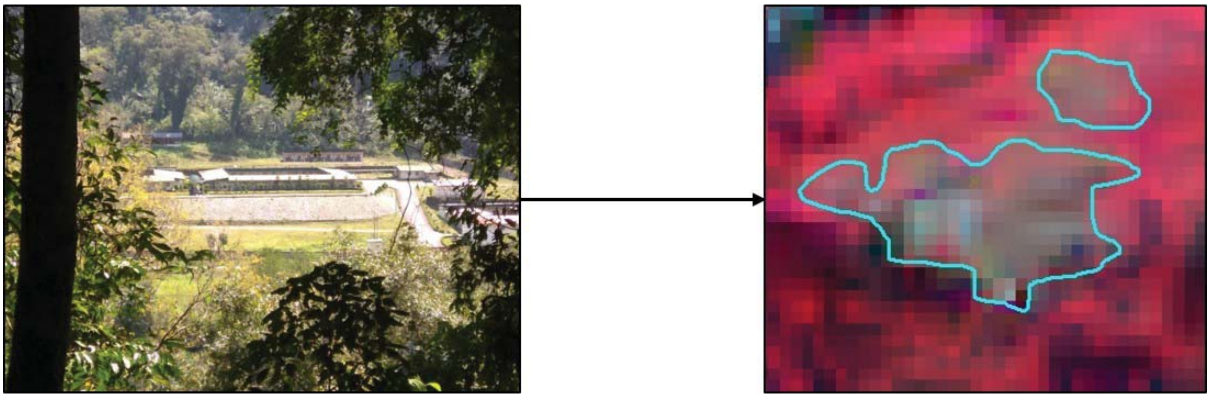
River

River and water channels, were clearly seen on the satellite imagery in blue and cyan colour depending on the depth of water, with a long narrow / wide pattern, a distinct feature associated with the drainages on hill slope.

River on the ground and delineation in satellite image

Settlements

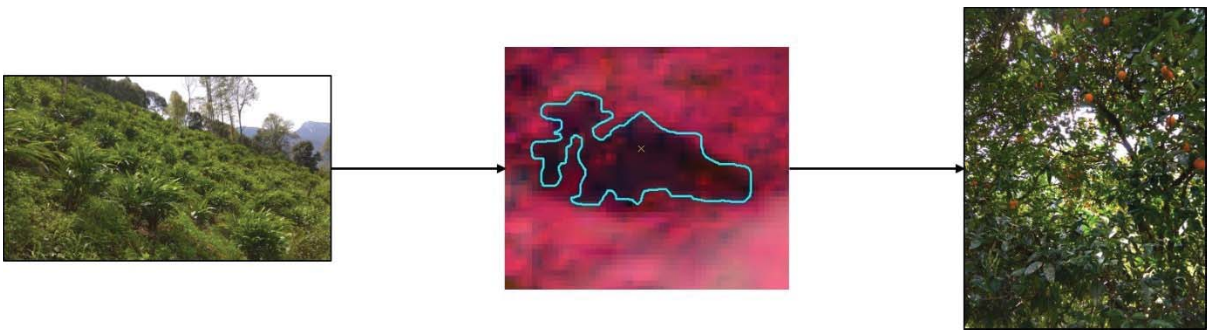
The settlements areas are identified by its greyish tone in the FCC image. Ii shows a light, rough and defined shape, which are mostly associated with the Orchards. Some of the villages that are having single households are mapped by collecting ground truth of the village.



Settlements on the ground and delineation in satellite image

Orchards

This category comprises of the various plantation and agricultural activity in the study area. The elaichi, orange and other citrus fruits are the major plantations found. They appear as a well-defined land parcels with smooth dotted texture and dark tone, where it is mostly associated with the settlements.



The various ground truth locations of settlements, roads and the other landscape features were collected to refine the classified satellite image.

5.1.2 Terrain and Topographic Features

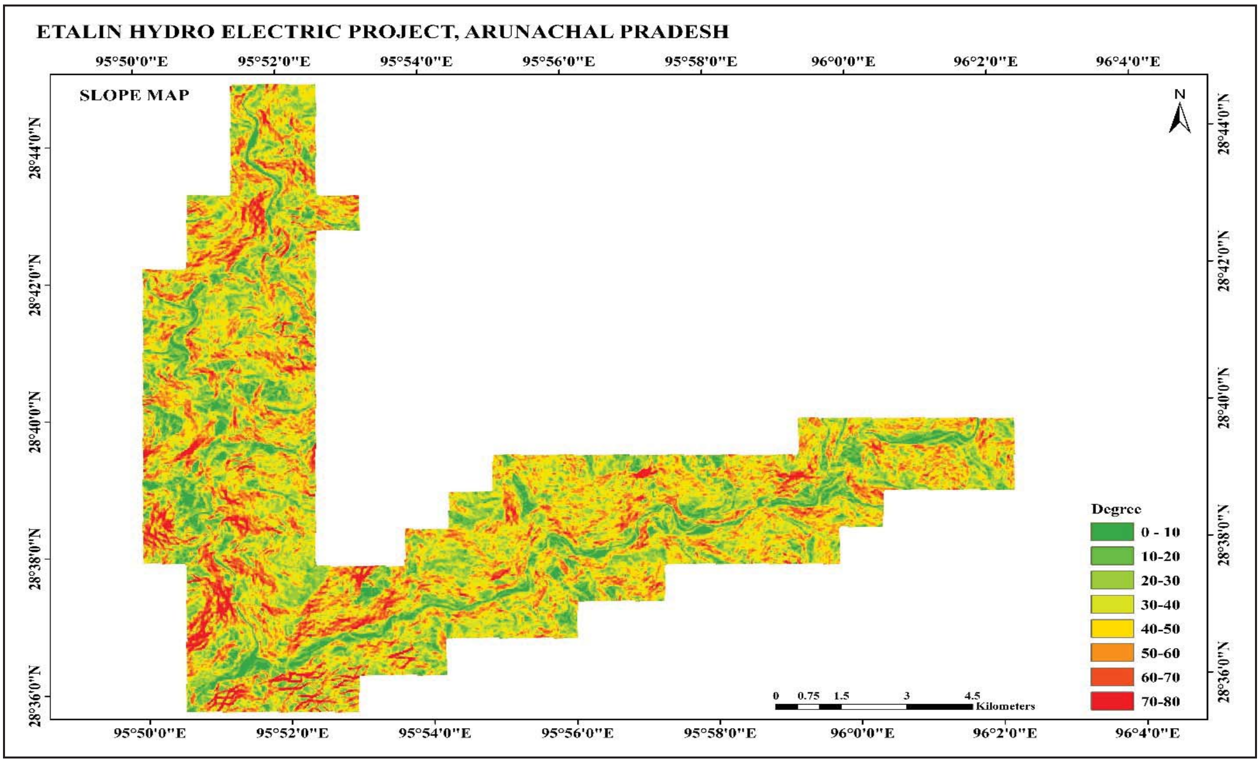
In this section the Slope, Aspects and the terrain features of Etalin HEP study Area are discussed (**Maps 5.2, 5.3 & 5.4**)

5.1.2.1 Slope

Cartosat DEM were used to generate Slope and Aspect of the study area. Slope and Aspect are the important triggering factors that determines the hazardousness of an area. Higher slope values indicate steeper terrain while lower values represent flatter terrain. The range of elevation of the study area is from 540mts to 2327mts. In majority of the study area, slope varies between 30-50 degrees (**Table 5.2**). **Map 5.2**, shows the slope characteristics of the study area.

Table 5.2: Extent (km²) and relative % of different Slope classes of Etail HEP Study Area

S. No	Classes	Area (Sq. km)	%
1	0-10	5.61	5.05
2	10-20	10.92	9.75
3	20-30	17.93	16
4	30-40	24.09	21.5
5	40-50	25.17	22.47
6	50-60	17.01	15.18
7	60-70	8.28	7.39
8	70-80	2.99	2.66
	Total	112	100



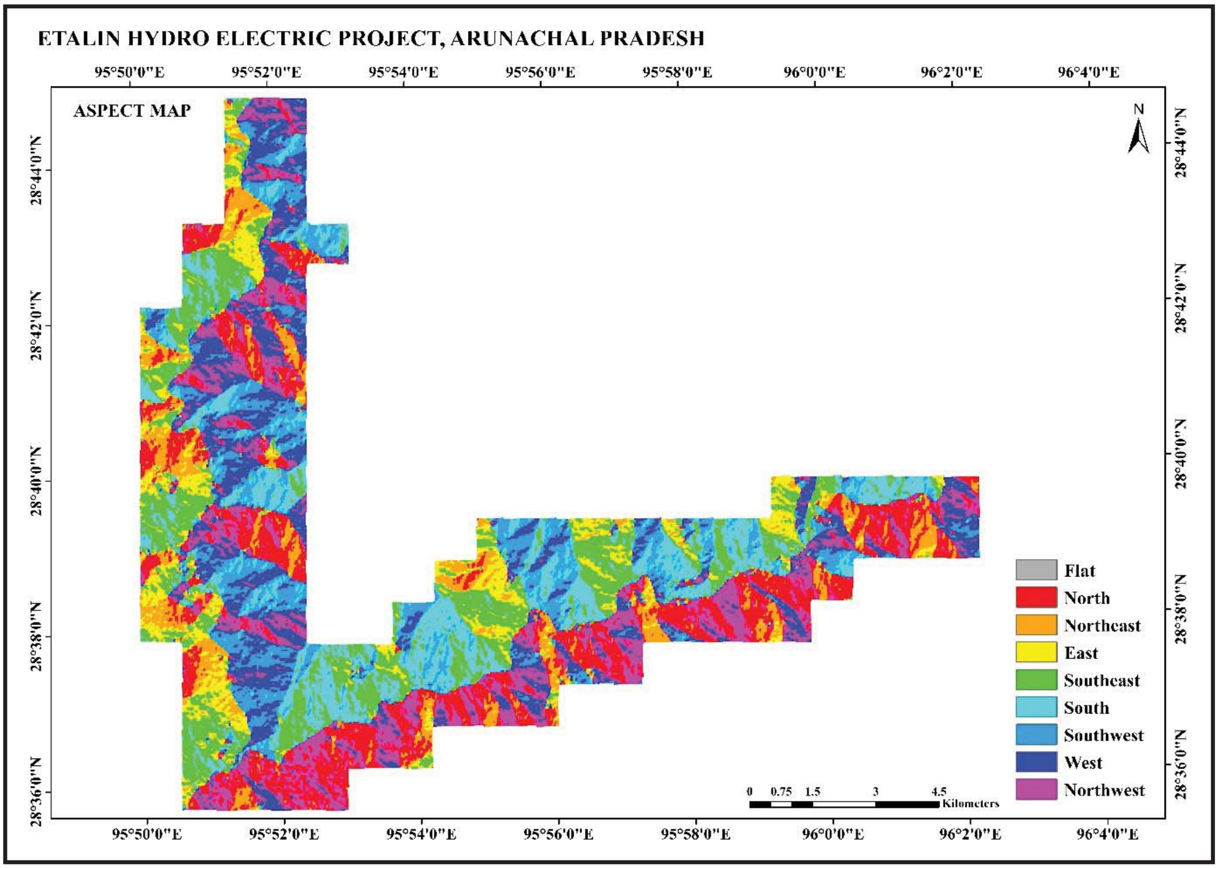
Map 5.2: Slope map of the Etalin HEP Study Area

5.1.2.2 Aspect

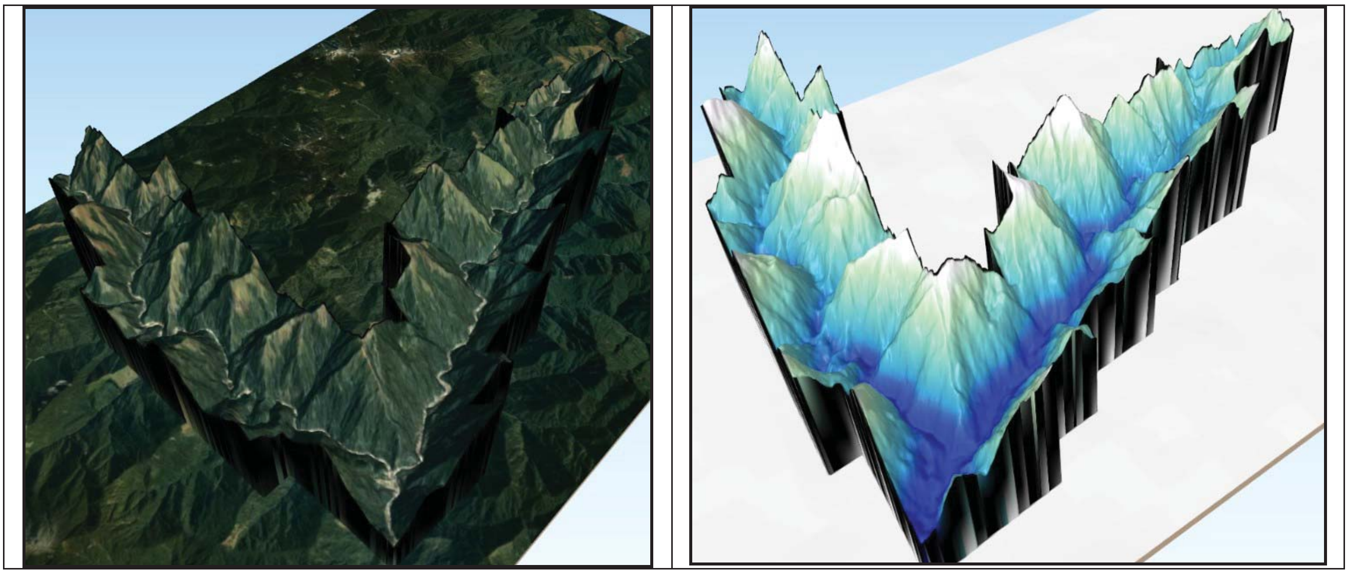
The aspect has significance in understanding the slope stability. Usually southeast (SE) to south (S) and southwest (SW) slopes are comparatively more prone to slope failure and sliding activities in Himalayas. In addition, aspect identifies the downslope direction of the maximum rate of change in value from each cell to its neighbour. In the study region, however, northern and southern aspects or facing slopes were comparatively more, most of the other aspects were also not much different in terms of representation in the study area. The representation of flat terrain was very low (**Table 5.3**). **Map 5.3** shows the different aspects of the mountainous terrain of the study area.

Table 5.3: Extent (km^2) and Relative % of different aspect types in the Etalin HEP Study Area

S. No	Class	Area (Sq. km)	%
1	Flat	0.0042	0.0038
2	North	17.42	15.56
3	Northeast	10.22	9.12
4	East	9.19	8.21
5	Southeast	14.34	12.80
6	South	16.58	14.80
7	Southwest	14.79	13.20
8	West	13.87	12.38
9	Northwest	15.56	13.89
Total		**112**	**100**



Map 5.3: Aspect map of the Etalin HEP Study Area



Map 5.4: 3D Maps of the Etalin HEP Study Area showing the Steepness of Terrain

5.2 Terrestrial Biodiversity

5.2.1 Status of flora

In total, 398 plant species were collected and identified, belonging to 106 families and 286 genera (**Table 5.4 & Annexure 5.I**) from Etalin HEP study area. Asteraceae and Poaceae were the dominant families, represented by 24 plant species each, followed by Urticaceae (20 species), Fabaceae (18 species), Rubiaceae (14 species) and Orchidaceae (12 species). Of the total, 270 species (86 families with 206 genera) were recorded from Dri basin and 301 species (80 families with 208 genera) were recorded from Tangon basin. Five families of gymnosperm were reported from the study area, of which two were recorded in the present study, with one species each from Dri basin and Tangon basin (**Table 5.4 & Annexure 5.2**). A total of 13 species of pteridophytes belonging to eight families were reported from the area. Of these 13 species seven species each were recorded along Dri and Tangon limbs (**Table 5.4 & Annexure 5.3**).

The proportion of species in the study area under each taxon was in following order: herb (30%) > tree (23%) > climbers (17.4%) > shrub (16.5%) > grasses and sedges (7%) > orchid (3%) and pteridophyte (3%). Similarly, in Dri basin (270 species), herb (30%) > tree (24%) > climbers (19%) > shrub (17%) > grasses & sedges (5%) > orchid and pteridophyte (3% each), while herb (33%) > tree (22%) > climbers (19%) > shrub (14%) > grasses & sedges (8%) > orchid and pteridophyte (2% each) in Tangon basin (**Table 5.4**).

Table 5.4: Status of different Floral Life Forms in EHEP Study Area

Habit	Dri limb	Tangon limb	Total species
Angiosperms			
Tree	70	70	95
Shrub	47	45	66
Climber	51	55	71

Orchid	8	7	12
Herb	80	98	125
Grass & sedge	14	26	29
Sub Total	**270**	**301**	**398**
Gymnosperm	**1**	**1**	**2**
Pteridophyte	**7**	**7**	**13**
Total	**278**	**309**	**413**

5.2.1.1 Vegetation Community Composition

Tree layer

Total of 58 tree species were encountered through quadrat sampling, which was 63.7% of the total tree species (91 species) recorded in the study area. Of the total 58 species, 88% (51 species) and 90% (52) species were recorded from Dri basin and Tangon basin, respectively. The 51 species formed 79.7% of the recorded species (64 tree species) along the Dri basin, while 52 species recorded in the Tangon basin accounted for 77.6% of the total tree species (67 species) recorded in the area through inventory (**Tables 5.4 & 5.5**).

Along the Dri basin, *Castonopsis indica* had the highest density (57.75±12.95 trees ha^{-1}) followed by *Macaranga denticulata* (36.62±10.47 trees ha^{-1}) and *Engelhardtia spicata* (35.21±8.53 trees ha^{-1}). In terms of total basal area of a species (TBA) and Importance Value Index (IVI) *Castonopsis indica* had maximum value (3.45 $m^{-2}ha^{-1}$ and 40.1, respectively). *Lithocarpus pachyphyllus* (2.53 $m^{-2}ha^{-1}$ and 20.21) accounted for second highest values for TBA. In terms of IVI *Engelhardtia spicata* (1.28 $m^{-2}ha^{-1}$ and 21.42) and *Mecaranga denticulata* (1.02 $m^{-2}ha^{-1}$ and 20.66) followed *Castonopsis indica* (**Table 5.5**).

Along the Tangon basin, *Castonopsis indica* had the highest density (93.55±19.22 trees ha^{-1}) followed by *Ficus semicordata* (40.32±12.90 trees ha^{-1}) and *Diploknema butyraceoides* (27.42±14.39 trees ha^{-1}). In terms of total basal area of a species *Castonopsis indica* had maximum value (4.86 $m^{-2}ha^{-1}$) followed by *Diploknema butyraceoides* (2.42 $m^{-2}ha^{-1}$) and *Terminalia myocarpa* (2.26 $m^{-2}ha^{-1}$). *Castonopsis indica* (53.27) accounted for highest value of IVI in the region. *Ficus semicordata* (19.12) and *Diploknema butyraceoides* (18.80) followed *Castonopsis indica* (**Table 5.5**).

Table 5.5: Importance Value Index of Tree species of Etalin HEP Study Area

S.No.	Plant species	Dri basin			Tangon basin		
		Trees (ha^{-1}±SE)	TBA ($m^{-2}ha^{-1}$)	IVI	Trees (ha^{-1}±SE)	TBA ($m^{-2}ha^{-1}$)	IVI
1	*Castonopsis indica*	57.75±12.95	3.45	40.08	93.55±19.22	4.86	53.27
2	*Engelhardtia spicata*	35.21±8.53	1.28	21.42	6.45±4.52	0.19	3.39
3	*Macaranga denticulate*	36.62±10.47	1.02	20.66	11.29±4.66	0.36	7.60
4	*Lithocarpus pachyphyllus*	19.72±9.75	2.53	20.21	14.52±9.44	0.98	8.93
5	*Ficus semicordata*	29.58±9.70	0.58	14.92	40.32±12.90	0.92	19.12
6	*Diploknema butyraceoides*	0.00±0.00	0.00	0.00	27.42±14.39	2.42	18.80

S.No.	Plant species	Dri basin			Tangon basin		
		Trees (ha^{-1}±SE)	TBA ($m^{-2}ha^{-1}$)	IVI	Trees (ha^{-1}±SE)	TBA ($m^{-2}ha^{-1}$)	IVI
7	*Ostodes paniculate*	35.21±12.22	0.87	17.20	17.74±9.35	0.30	8.09
8	*Lithocarpus fenestratus*	30.99±12.13	1.36	16.98	0.00±0.00	0.00	0.00
9	*Castanopsis tribuloides*	29.58±10.69	0.85	14.68	1.61±1.61	0.25	1.99
10	*Litsea cubeba*	33.80±10.79	0.38	13.66	17.74±10.91	0.14	6.80
11	*Bischofia javanica*	28.17±9.86	0.67	13.37	6.45±3.90	0.15	3.85
12	*Kydia calycina*	5.63±2.76	0.14	3.74	12.90±4.87	1.28	12.35
13	*Terminalia myocarpa*	1.41±1.41	0.01	0.78	6.45±3.90	2.26	12.50
14	Others	180.28	4.11	99.81	219.35	10.24	141.21
	Total	**523.98**	**17.25**		**475.79**	**24.35**	

Shrub layer

A total of 37 shrub species was encountered through quadrat sampling, which was 56% of the total shrub species (66 species) recorded using all methods. Of the 37 species, 26 and 28 species were recorded from the Dri basin and the Tangon basin, respectively. These 26 species formed 58% of the total recorded species (45 shrub species) in the Dri basin, and 28 species recorded in the Tangon basin accounted for 65% of the total shrub species (43 species) recorded in the area (**Tables 5.4 & 5.6**).

Along the Dri river, *Strobilanthes sp.* had the highest density (726.8±205.1 shrubs ha^{-1}) followed by *Psychotria monticola* (642.3±134.6 shrubs ha^{-1}) and *Piper pedicellatum* (631.0±156.6 shrubs ha^{-1}). In terms of prominence value index (PVI) *Psychotria monticola* accounted for maximum value (36.9) followed by *Piper pedicellatum* (33.7) and *Strobilanthes sp* (32.0) (**Table 5.6**).

Along the Tangon river, *Piper pedicellatum* had the highest density (896.8±236.6 shrubs ha^{-1}) followed by *Rhynchotechum ellipticum* (303.2±112.9 shrubs ha^{-1}) and *Psychotria monticola* (245.2±87.4 shrubs ha^{-1}). In terms of prominence value index (PVI) *Rhynchotechum ellipticum* had maximum value (27.5) followed by *Psychotria monticola* (21.1) and *Phlocanthus curviflorus* (18.2) (**Table 5.6**).

Table 5.6. Prominence Value Index of Shrub species of Etalin HEP Study Area

S. No	Plant species	Dri basin			Tangon basin		
		Shrub (ha^{-1}±SE)	Frequency (%)	PVI	Shrub (ha^{-1}±SE)	Frequency (%)	PVI
1	*Psychotria monticola*	642.3±134.6	32.4	36.9	245.2±87.4	14.5	21.1
2	*Piper pedicellatum*	631.0±156.6	26.8	33.7	896.8±236.6	24.2	3.6
3	*Strobilanthes sp.*	726.8±205.1	19.7	32.0	103.2±59.6	6.5	9.2
4	*Rhynchotechum ellipticum*	163.4±55.3	14.1	12.4	303.2±112.9	14.5	27.5
5	*Oreocnide sp.*	140.8±50.8	14.1	11.7	32.3±23.1	3.2	3.6
6	*Rubus ellipticus*	140.8±46.2	12.7	11	0	0	0
7	*Phlocanthus curviflorus*	11.3±11.3	1.4	1.1	187.1±63.5	14.5	18.2

S. No	Plant species	Dri basin			Tangon basin		
		Shrub (ha^{-1}±SE)	Frequency (%)	PVI	Shrub (ha^{-1}±SE)	Frequency (%)	PVI
8	*Laportea sp.*	146.5±62.8	8.5	9	129.0±51.9	9.7	12.4
9	*Boehmeria macrophylla*	39.4±21.5	5.6	4.2	174.2±41.8	9.7	14.6
10	*Sambucus hookeri*	39.4±25.6	4.2	3.4	90.3±32.4	16.1	14.6
11	*Chloranthus elatior*	16.9±16.9	1.4	1.3	129.0±52.7	9.7	12.4
12	*Debregeasia sp.*	174.6±80.5	9.9	9.8	71.0±37.4	6.5	7.5
13	*Boehmeria longifolia*	0	0	0	77.4±37.3	8.1	8.8
14	*Solanum spirale*	73.2±33.4	8.5	6.7	25.8±25.8	1.6	2.3
15	Others	259	30.3	26.8	367.9	40.1	43.3
	Total	**3205.4**			**2832.4**		

Climbers

In total 49 climber species were enumerated through quadrat sampling, which was 68% of the total climber species (72 species) recorded. Of these 49 species, 32 species and 39 species were recorded from Dri limb and Tangon limb, respectively. The 32 species formed 64% of the total recorded species (50 climber species) along the Dri limb, while 39 species recorded in the Tangon limb accounted for 70% of the total climber species (56 species) recorded in the area (**Tables 5.4 & 5.7**).

Along the Dri river, *Rhaphitophora decursiva* had the highest density (535.2±105.2 climbers ha^{-1}) followed by *Tetrastigma affine* (360.6±75.8 climber ha^{-1}) and *Piper clerki* (174.6±49.9 climber ha^{-1}). In terms of prominence value index (PVI) also *Rhaphitophora decursiva* had maximum value (32.2) followed by *Tetrastigma affine* (26.7) and *Piper clerki* (12.9) (**Table 5.7**).

Along the Tangon river, *Rhaphitophora decursiva* had the highest density (471.0±101.0 climber ha^{-1}) followed by *Tetrastigma affine* (451.6±96.2 climbers ha^{-1}) and *Rhaphidophora hookeri* (329.0±78.3 climbers ha^{-1}). In terms of prominence value index (PVI) *Rhaphitophora decursiva* had maximum value (26) followed by *Tetrastigma affine* (24) and *Rhaphidophora hookeri* (18.9) (**Table 5.7**).

Table 5.7. Prominence Value Index of Climbers of Etalin HEP Study Area

S. No	Plant species	Dri basin			Tangon basin		
		Climber (ha^{-1} ± SE)	Frequency (%)	PVI	Climber (ha^{-1} ± SE)	Frequency (%)	PVI
1	*Rhaphitophora decursiva*	535.2±105.2	32.4	32.3	471.0±101.0	33.9	26
2	*Tetrastigma affine*	360.6±75.8	32.4	26.7	451.6±96.2	32.3	24
3	*Piper clerki*	174.6±49.9	16.9	12.9	174.2±87.6	8.1	8.1
4	*Smilax* sp.	129.6±40.7	16.9	11.2	64.5±39.2	4.8	3.6
5	*Clematis acuminate*	112.7±31.3	18.3	11.1	25.8±18.1	3.2	1.9
6	*Stephania* sp.	118.3±45.0	12.7	9.2	45.2±27.8	4.8	3.1
7	*Periploca calophylla*	152.1±62.9	8.5	8.9	0	0	0
8	*Milletia pachycoyea*	95.8±40.5	9.9	8.8	6.5±6.5	1.6	1.6
9	*Piper* sp 3.	118.3±47.1	9.9	8.2	0	0	0
10	*Piper sylvertica*	107.0±42.4	9.9	7.7	141.9±52.1	12.9	9.9
11	*Rhaphidophora hookeri*	56.3±23.1	8.5	5.3	329.0±78.3	25.8	18.9

S. No	Plant species	Dri basin			Tangon basin		
		Climber (ha^{-1} ± SE)	Frequency (%)	PVI	Climber (ha^{-1} ± SE)	Frequency (%)	PVI
12	*Poilokospermum lanceolatum*	22.5±13.6	4.2	2.4	271.0±71.1	27.4	18.7
13	*Piper* sp 4.	0	0	0	219.4±103.1	8.1	8.1
14	*Piper* sp 1	50.7±32.0	4.2	3.5	212.9±85.7	11.3	7.4
15	*Piper rhytidocarpun*	0	0	0	109.7±66.4	4.8	5
16	*Embilya floribunda*	78.9±36.4	8.5	6.1	0	0	0
17	*Steptoleleon volabulis*	39.4±30.2	2.8	2.5	77.4±47.7	4.8	4
18	*Acacia pennata*	22.5±15.8	2.8	1.9	77.4±31.6	11.3	6.3
19	Others	423		41.3	621.7		53.4
	Total	**2596.9**			**3299.2**		

5.2.1.2 Species Richness and Diversity

Dam submergence area (DSA) accounted for maximum value for tree (species richness 40; H’= 3.1) form, shrub (species richness 76; H’= 3.5) and herb layer (species richness 67; H’= 3.6) richness and diversity in the study area. Least value for tree (species richness 9; H’= 1.6) and shrub (species richness 17; H’= 2.5) layer richness and diversity was recorded at quarry sites (QS), while areas proposed for colony, camps and offices (CCO) recorded least values for species richness and diversity for herbaceous layer (species richness 17; H’= 2.4) (**Table 5.8**).

Table 5.8. Species Richness and Diversity (Shannon-Weiner diversity index, H’) across different Impact Zones of the Etalin HEP Study Area

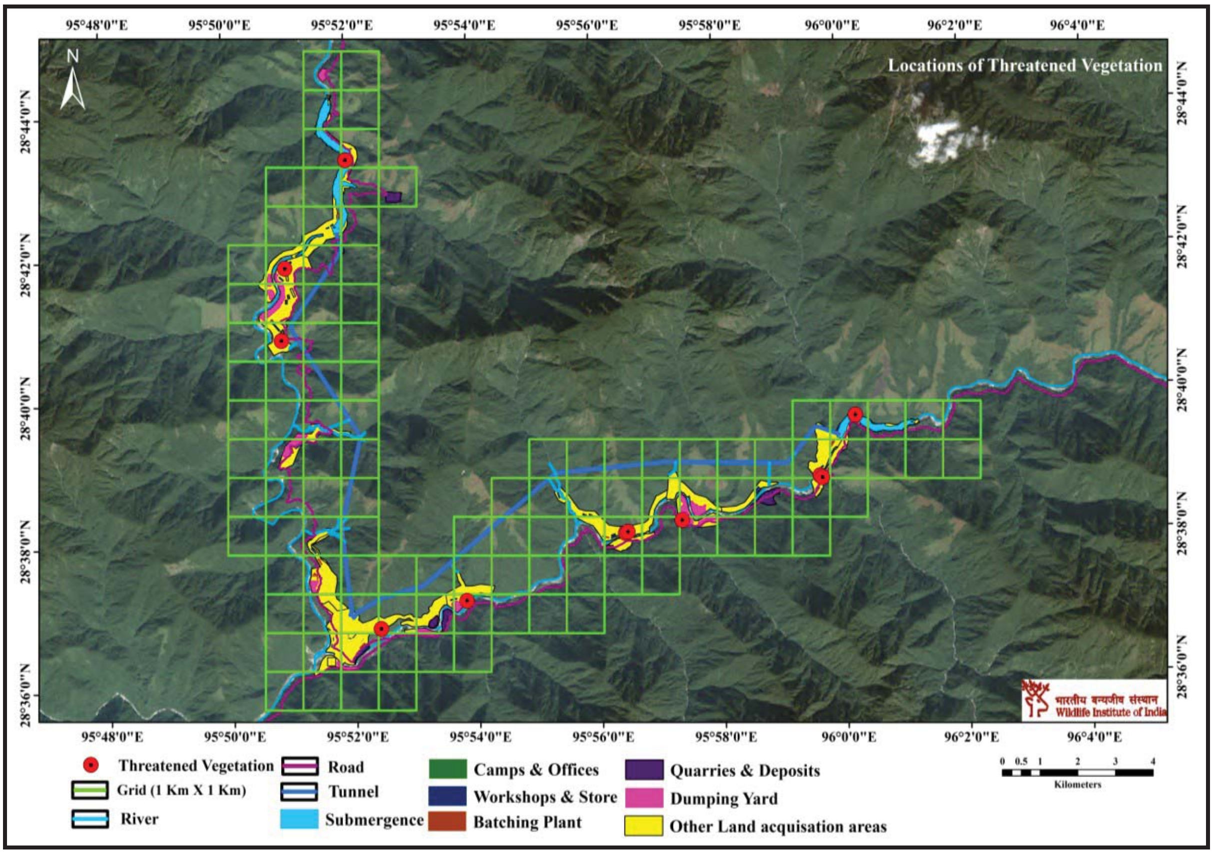
Impact Zones	Dri		Tangon		Study area	
	Species Richness	Shannon-Weiner diversity index (H’)	Species Richness	Shannon-Weiner diversity index (H’)	Species Richness	Shannon-Weiner diversity index (H’)
PH & C						
Tree	26	2.9	-	-	26	2.9
Shrub	24	2.5	-	-	24	2.5
Herb	23	2.8	-	-	23	2.8
DSA						
Tree	29	2.8	21	2.7	40	3.1
Shrub	48	3.1	47	3.5	76	3.5
Herb	39	3.1	44	3.4	67	3.6
DS						
Tree	-	-	-	-	-	-
Shrub	-	-	-	-	-	-
Herb	-	-	-	-	-	-
DY						
Tree	12	2.2	19	2.6	24	2.8

Impact Zones	Dri		Tangon		Study area	
	Species Richness	Shannon-Weiner diversity index (H')	Species Richness	Shannon-Weiner diversity index (H')	Species Richness	Shannon-Weiner diversity index (H')
Shrub	21	2.7	33	3.1	39	3.2
Herb	13	2.2	23	2.7	33	3.1
QS						
Tree	-	-	9	1.6	9	1.6
Shrub	-	-	17	2.5	17	2.5
Herb	-	-	16	2.6	16	2.6
W/B						
Tree	16	2.3	14	2.1	25	2.7
Shrub	21	2.6	15	2.2	29	2.6
Herb	24	2.8	24	2.9	38	3.3
CCO						
Tree	10	1.9	10	2.0	18	2.5
Shrub	19	2.4	9	1.8	25	2.7
Herb	5	1.5	12	2.3	17	2.4
OT						
Tree	9	1.9	17	2.5	25	2.8
Shrub	15	2.2	24	2.9	33	3.1
Herb	22	2.5	22	2.7	36	3.2
NIZ						
Tree	-	-	13	2.2	13	2.2
Shrub	-	-	25	23.00	25	3.00
Herb	-	-	28	2.8	28	2.8
Total						
Tree	**70**	**3.3**	**70**	**3.4**	**95**	**3.6**
Shrub	**47**	**3.4**	**45**	**3.6**	**66**	**3.7**
Herb	**80**	**3.6**	**98**	**3.7**	**125**	**3.9**

* PH & C=powerhouse and confluence, DSA=dam submergence site, DS= dam site, DY=dump yard, QS= quarry site, W/B= workshop and batching plant, CCO= camps, colony and office, OT= other land use, NIZ= Non-impact zone

5.2.1.3 Status of Species of Conservation Significance

The species of conservation significance includes species listed in IUCN Red List for plants, list as Schedule V, of Indian Wildlife Protection Act 1972 and endemic/range restricted species. In the present study one plant species, *Piper pedicellatum*, a Vulnerable (VU) species of IUCN Red List of plant, was mentioned as Vulnerable (VU) by IUCN, was recorded. Although due to its locally abundant density, BSI (http://bsienvis.nic.in/Database/E_3942.aspx), has not listed it as threatened. Nine species has been listed as endemic (**Table 5.9**). **Map 5.5**, shows the distribution of the plant species of conservation significance within the study area,



Map 5.5: Locations of the Plants Species of Conservation Significance in Etalin HEP Study Area

Table 5.9: Status of Species of Conservation Significance (RET and endemic species) in Etalin HEP Study Area

Species	Growth Form	Status
Piper pedicellatum	Shrub	Vulnerable
Bauhinia ovalifolia	Climber	Endemic
Calamus leptospadix	Climber	Endemic
Chirita macrophylla	Herb	Endemic
Loxostigma griffithii	Herb	Endemic
Phlogacanthus tubiflorus	Shrub	Endemic
Pilea insolens	Herb	Endemic
Piper petiolatum	Climber	Endemic
Rhaphidophora hookeri	Climber	Endemic

5.2.1.4 Overall Status of Plant Species in and around Etalin HEP Study Area

Overall 563 angiosperm species belonging to 368 genera and 110 families were reported from in and around the study area, which is based on the cumulative list of plant prepared by combining the present study list and the list collated from the secondary sources (EIA 2015) (**Table 5.10**). Of the total 563 species, 32% /180 species were common to both the present study and the list collated from previous studies (secondary source), 38.9% / 219 species were recorded only during the present study and 29.1% / 164 species were reported only from secondary source / previous studies (**Annexure 5.1**). Eight gymnosperms belonging to five families were reported from the area, of which one was recorded during the current study, while one was common to both the studies and six species were reported only from earlier study (**Annexure 5.2**). For pteridophytes, 31 species were listed of which 18 species were reported only by earlier studies, nine species were common to both the study and four species were recorded only in the present study (**Annexure 5.3**).

Table 5.10: Overall Status of Plants in and around Etalin HEP Study Area, Dibang Valley, Arunachal Pradesh

Taxonomic Status	Present Study	Secondary Source	Overall
Family	95	87	110
Genera	274	247	368
Species	398	342	563

Secondary Source: EIA Study 2015

Plate 5.1: Some of the Floral Species recorded from the Etalin HEP study area	
	
Bauhinia ovatifolia	***Musa aurantiaca***
	
Chirita dibangensis	***Psychotria monticola***
	
Vanda cristata	***Anoectochilus brevilabris***

5.2.2 Status of Entomofauna

5.2.2.1 Butterflies

a) Taxonomic Richness

In total, during this study, that covered two season survey, a total of 159 species of butterflies belonging to 77 genera spread over six families were identified, three of which are listed under the

Wildlife Protection Act, 1972 (WPA 72). Of the total 159 species recorded, 147 species (75 genera and six families) were recorded from Dri and 125 (67 genera and six families) from Tangon (**Table 5.11**), the former accounting for 92.5% of total species recorded and the latter about 79% (**Table 5.12**).

The Dri basin had higher species richness as compared to the Tangon basin, in spite of all the pre-existing anthropogenic stress, and ongoing highway expansion and extension till Anini. This could partly be due Dri having a wider valley and hence have more space vis-à-vis microhabitats and niches. Disturbance due to road construction could have led to formation of more edges, ecotonal areas, that could have attracted butterflies, of both forest as well as open areas, Further, the wetness of substrate and appearance of many small puddle due to moving of the earth also had attracted species due to availability of several localized nutrient-rich puddles, moisture rich sites and water seepages through the rocks. Most of the butterflies recorded were seen mud puddling on the moisture rich open patches on the road. Some species like Great Nawab, Blue Tit and Tabby were often seen feeding on bird droppings. They were also observed hovering around partially cleared forest areas and frequently settling in shaded areas. Another probable reason could be loss of forest cover along the road side that could have flushed out the forest interior species onto the open patches, which were recorded while crossing the open areas to reach areas with better cover, which is their regular home.

Table 5.11: Taxonomic Richness of Butterflies in Etalin HEP Study Area

Sites	Family	Genera	Species
Dri basin	6	75	147
Tangon basin	6	67	125
Study Area	6	77	159

b) *Species Richness in different Impact Zones*

It is to be mentioned here that as the project is still in the proposed / planning stage, there are no sites that have been disturbed for any project-based activity, but for the study purpose the sites identified for particular project activity-based land uses, were assessed and sampled. On these lines, the areas which did not have any activity planned by the project are treated as Non-impact zones (NIZ), which accounted for maximum (Dri- 56.46%, Tangon- 58.4% and overall study area- 67.9%) richness of species (**Table 5.12**). The richness and relative % of species in different impact zones, in addition to providing information on baseline, would serve to visualize the impacts due to various activities.

Table 5.12: Richness and Relative % of Butterfly Species recorded in different Impact Zone of Etalin HEP Study Area

Impact Zones	River Dri		River Tangon		Study Area	
	Richness	Relative %	Richness	Relative %	Richness	Relative %
PH&C	57	38.8	-	-	57	35.9
DSA	48	32.7	41	32.8	69	43.4
DS	14	9.5	14	11.2	26	16.4

Impact Zones	River Dri		River Tangon		Study Area	
	Richness	Relative %	Richness	Relative %	Richness	Relative %
QS	35	23.8	36	28.8	55	34.6
DY	39	26.5	52	41.6	68	42.8
W/B	26	17.7	16	12.8	33	20.8
CCO	29	19.7	53	42.4	63	39.6
OT	76	51.7	57	45.6	95	59.8
NIZ	83	56.5	73	58.4	108	67.9
TOTAL	147	100	125	100	159	100
Comparison with Study Area	147	92.5	125	78.6	-	-

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones

c) Similarity of Species between different Impact Zones (Jaccard's Similarity Index)

***Dri river*: ** Butterfly species showed a high similarity of 45% between OT and NIZ, followed by QS and DSA (35.2 %). The lowest percentage of similarity was between PH&C and DS (6.06%) (**Table 5.13**). However, this low similarity could be due to both sites being separated by fairly long distance, the overall less similarity between the different zone, reveals the significance of each zone as they have more species of butterflies unique to the respective sites. So, different project activities planned at these sites would have an impact on the species, in the form of loss of vegetation, degradation and disturbance, that could result in local disappearance of certain species and change in species compositions.

Table 5.13. Similarity Matrix (in %) of Butterfly species between different Impact Zones along Dri river in the Etalin HEP Study Area

Impact Zones	PH&C	DSA	DS	QS	DY	WB	CCO	OT	NIZ
PH&C	100								
DSA	25	100							
DS	6.1*	13.0	100						
QS	24.7	35.2	11.6	100					
DY	21.5	27.9	10.6	25.4	100				
WB	20.3	21.3	8.3	24.5	23.1	100			
CCO	21.1	24.2	10.5	25.5	21.4	34.2	100		
OT	31.7	22.8	7.2	22.0	25	25.9	25	100	
NIZ	28.7	34.0	6.7	23.2	27.4	22.7	32.1	45**	100

*Least similarity; **Highest similarity; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones

Tangon river: Along the Tangon river also the similarity between different project land use or impact zones was less, with all the sites showing similarity of < 40%, except for 43.2% similarity between NIZ and CCO (**Table 5.14**). More dissimilarity between impact zone show that the project activities in the respective zone would have an impact on species richness and composition. Care must be taken to keep this effect to the minimum, possibly taking proper precautions and mitigations.

Table 5.14. Similarity Matrix (in %) of Butterfly species between different Impact Zones along Tangon river in the Etalin HEP Study Area

Impact Zones	DSA	DS	QS	DY	WB	CCO	OT	NIZ
DSA	100							
DS	17.02	100						
QS	35.09	13.64	100					
DY	30.99	13.79	35.38	100				
WB	18.75	25	20.93	19.29	100			
CCO	27.03	15.52	28.99	40	13.11*	100		
OT	25.64	20.33	29.17	34.57	23.73	39.24	100	
NIZ	35.71	16	28.24	42.05	20.27	43.18**	35.42	100

*Least similarity; **Highest similarity; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

d) Status of Threatened Species

In the study area three butterfly species listed as Schedule I of the Wildlife Protection Act 1972, were recorded. Among these, Pale Jezebel (PJ) was reported from QS and DY, Scarce Jester in QS, DY, CCO, OT, and NIZ, and Spotted Black Crow was seen in DY, CCO, OT and NIZ (**Table 5.15 & Map 5.6**). The presence of RET or species of conservation significance along both the rivers, shows the importance of the habitat and plant species at each project activity site / impact zone for these species. Disturbance of any sort will lead to disappearance of that species, decrease in their numbers and overall decrease in species richness of butterflies as a whole.

Pale Jezebel, Scarce Jester and Spotted Black Crow were also recorded along the Dri and Tangon basins. In terms of significance of sites for these species, QS, DY, OT and NIZ are important sites along Dri, while DY, CCO, and NIZ are crucial sites of conservation along Tangon (**Table 5.15 & Map 5.6**). Before, starting to work on the particular site, care should be taken to create similar site condition in the adjoining area / try transplanting the herbs (perennials), grass and shrubs to an adjoining site if possible or recreate the conditions so that these butterfly species of conservation significance will have an abode to go and settle when disturbed here.

Table 5.15: Status of RET Species in different Proposed Project Activities / Land Uses of Etalin HEP Study Area

Impact Zones	Presence of RET Species								
	River Dri			River Tangon			Study Area		
	PJ	SJ	SBC	PJ	SJ	SBC	PJ	SJ	SBC
PH&C	-	-	-	-	-	-	-	-	
DSA	-	-	-	-	-	-	-	-	-
DS	-	-	-	-	-	-	-	-	-
QS	*	*	-	-	-	-	*	*	-
DY	*	-	*	*	*	-	*	*	*
W/B	-	-	-	-	-	-	-	-	-
CCO	-	-	-	-	*	*	-	*	*
OT	-	*	*	-	-	-	-	*	*
NIZ	-	*	*	*	*	*	*	*	*

*Presence of species; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

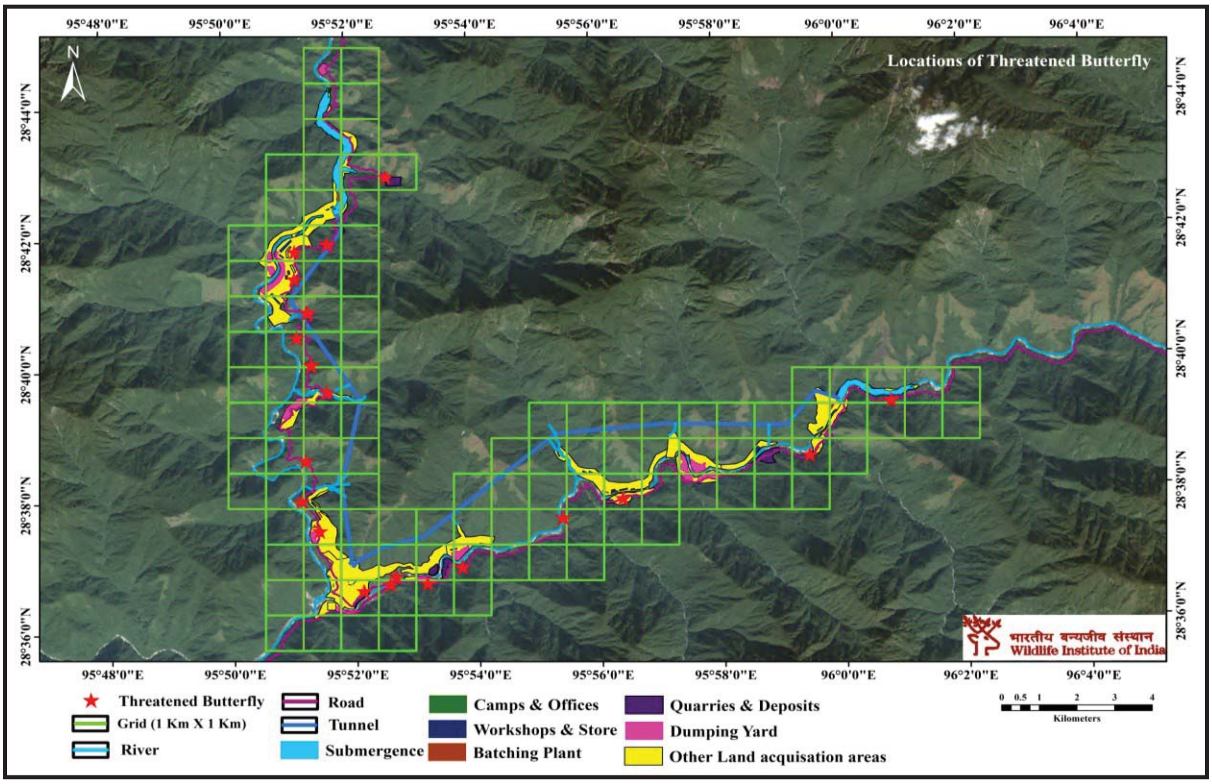
e) Overall Status of Butterflies in and around Etalin HEP Study Area

Based on the present study a total of 159 butterfly species were recorded. The search for butterfly in the published secondary source (EIA Study 2016) resulted in collation of 45 species. These two lists were combined and the cumulative list of butterflies that is possible to occur in the Etalin HEP study area and its environs is 179 species belonging to 86 genera and six families (**Table 5.16**). Among these 25 species were common to both the present study and the list prepared based on secondary source, 20 species were reported only from secondary source and 134 were recorded only during the present study (**Annexure 5.4**).

Table 5.16: Overall Status of Butterflies in and around Etalin HEP Study Area, Dibang Valley, Arunachal Pradesh

Taxonomic Status	Present Study	Secondary Source	Overall
Family	6	6	6
Genera	77	32	86
Species	159	45	179

Secondary Source: EIA Study 2016



Map 5.6: Location of Butterfly Species of Conservation Significance in Etalin HEP Study Area

5.2.2.2 Odonates

a) Taxonomic Richness

In total 11 Odonate species were identified in the study area, belonging to five genera and two families. They were usually found near streams and water channels. They were also seen hovering over small puddles of water on the roads or damp areas along the trails in the sparsely dense forest. The Odonates were comparatively less along the Tangon river compared to the Dri river (**Table 5.17 & Annexure 5.5**), mainly due to more water availability and temporary puddles formed on the newly being constructed road.

Table 5.17: Taxonomic Richness of Odonates in the Etalin HEP Study Area

Sites	Family	Genera	Species
Dri	2	5	11
Tangon	1	2	5
Study Area	2	5	11

b) Species Richness in different Impact Zones

The comparison of Odonate species richness between impact zones showed highest richness in PH&C with eight species, accounting for almost 73% of total species recorded, followed by six species each from DSA, DY and OT. Along the Dri river, eight species were recorded from PH&C, representing close to 73% of total recorded from the river, with the least richness recorded from DS, QS and W/B (one species each), accounting for 9% of the total (**Table 5.18**).

Along the Tangon river, DSA had for maximum species richness with four species, representing 80% of total species recorded and minimum richness was recorded from DS, DY and OT with two species each, representing 40% of total species recorded from the river (**Table 5.18**). The richness and relative % information would serve as crucial links in understanding how odonate species will be impacted across various impact zones of the study area.

Table 5.18: Richness and Relative % of Odonate species recorded in different Impact Zones of Etalin HEP Study Area

Impact Zones	River Dri		River Tangon		Study Area	
	Richness	Relative %	Richness	Relative %	Richness	Relative %
PH&C	8	72.7	-	-	8	72.7
DSA	5	45.5	4	80	6	54.5
DS	1	9.1	2	40	2	18.2
QS	1	9.1	-	-	1	9.1
DY	5	45.5	2	40	6	54.5
W/B	1	9.1	-	-	1	9.1
CCO	-	-	3	60	3	27.3
OT	5	45.5	2	40	6	54.5
NIZ	4	36.4	3	60	5	45.5
TOTAL	11	100	5	100	11	100
Comparison with Study Area	11	100	5	45.45	-	-

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

c) Similarity of Species between different Impact Zones (Jaccard's Similarity Index)

Dri river: The similarity of species among different impact zones along the Dri river showed maximum similarity of 50% between Non-impact Zone (NIZ) and Dump Yard (DY). This was followed by 44.4% between Dam Submergence Area (SBA) and Power House & Confluence (PH&C), and Others (OT) (**Table 5.19**). Even though the number of species recorded were less, the maximum similarity between impact zones along Dri was 50% or less, which makes all these different sites more crucial for the survival of these species. Hence, before getting into the implementation phase, care should be taken to provide alternative abode for these species and group.

Table 5.19: Similarity Matrix (%) of Odonate species between different impact zones along Dri river in the Etalin HEP Study Area

Impact Zones	PH&C	DSA	DS	QS	DY	WB	CCO	OT	NIZ
PH&C	100								
DSA	44.4	100							
DS	12.5	20	100						
QS	-	-	-	100					
DY	27.3	42.9	-	-	100				
WB	-	-	-	100	-	100			
CCO	-	-	-	-	-	-	-		
OT	44.4	42.9	20	20	12.5*	20	-	100	
NIZ	50**	33.3	25	-	50**	-	-	28.6	100

*Least Similarity, ** Highest similarity; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

Tangon river: The similarity among species between different impact zones along Tangon river seems to be comparatively more than that was recorded for the impact zones along the Dri river, but this could be an influence of very poor richness along the Tangon river. However, along this river, based on this species richness, maximum similarity of 66.7% was reported among OT and Camps, Colony and Offices (CCO), NIZ & DY, CCO & DY (**Table 5.20**). As discussed above care must be taken before implementation phase to provide proper alternative habitat for the rehabilitation of these Odonate species.

Table 5.20: Similarity Matrix (%) of Odonate species between different Impact Zones along Tangon river in the Etalin HEP Study Area

Impact Zones	DSA	DS	QS	DY	WB	CCO	OT	NIZ
DSA	100							
DS	50	100						
QS	0	0	0					
DY	50	33.3	0	100				
WB	0	0	0	0	0			
CCO	20	25	0	66.7**	0	100		
OT	20*	33.3	0	33.3	0	66.7**	100	
NIZ	75	25	0	66.7**	0	50	25	100

*Least Similarity, ** Highest similarity; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

Further, one of the specific species of conservation interest in the Etalin HEP study area was the Wandering Glider (*Pantala* flavescens), which even though was a common dragonfly, is known for the longest insect migration, that moves from East Africa to South-East Asia, covering a distance of more than 3500 kms (Anderson, 2009). Hence, it becomes more critical to provide habitat for this species before start of project activity implementation phase.

5.2.2.3 Spiders

a) Taxonomic Richness

In total 113 species (43 identified) belonging to 88 genera (84 identified) from 25 families were recorded from the study area. Among the two basins in the study area, 90 species were recorded in the Tangon basin, which was 80% of total species in the study area. This was more compared to 68 species recorded along Dri river, which formed 60% of the total species (**Tables 5.21, 5.22 & Annexure 5.6**). This group being comparatively more sedentary would get effected due to any disturbance related to habitat degradation and loss, than the other groups dealt above. Further, this group, also known to efficiently occupy new niches, would need the disturbance in the area to decrease or settle down, so as to move to new niches, which is not the case within the Dri basin where the disturbance and other activities due to construction of road is going on. This disturbance is comparatively almost nil along Tangon river, where still undisturbed and pristine patches of natural forest are available, which could be the probable reason for more spider species along this river.

Table 5.21: Taxonomic Richness of Spiders in Etalin HEP Study Area

Sites	Family	Genera	Species
Dri	22	58	68
Tangon	23	74	90
Study Area	25	88	113

Species Richness in different Impact Zones

The comparison of spider species richness in each impact zone with the study area richness showed that DSA had 56 species that formed almost 50% of the species recorded in the study area, followed by 55 species (48.7%) in DY and 49 species (43.4%) in OT, remaining formed comparatively lesser percent to the total. Similarly, along the Dri river, 40 species were recorded from DY, which formed 58.8% of the total species, while least contribution of 13.2% each, was from Workshops, Stores and Batching Plants (W/B) and CCO. Along the Tangon river, the major contribution was from DSA 36 species forming 40% of species, followed by OT (**Table 5.22**). This analysis reveals the significance of each impact zone in terms of species richness of the study rivers vis-à-vis study area.

Table 5.22: Richness and Relative % of Spider species recorded in different Impact Zones of Etalin HEP Study Area

Impact Zones	River Dri		River Tangon		Study Area	
	Richness	Relative %	Richness	Relative %	Richness	Relative %
PH&C	29	42.7	-	-	29	25.7
DSA	32	47.1	36	40	56	49.6

Impact Zones	River Dri		River Tangon		Study Area	
	Richness	Relative %	Richness	Relative %	Richness	Relative %
DS	10	14.7	14	15.6	18	15.9
QS	12	17.6	14	15.6	21	18.6
DY	40	58.8	29	32.2	55	48.7
W/B	9	13.2	9	10	14	12.4
CCO	9	13.2	29	32.2	32	28.3
OT	28	41.2	34	37.8	49	43.4
NIZ	23	33.8	29	32.2	43	38.1
TOTAL	68	100	90	100	113	100
Comparison with Study Area	68	60.2	90	79.7	-	-

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

b) Similarity of Species between different Impact Zones (Jaccard's Similarity Index)

Dri River: Highest species similarity of spider species among different impact zones along the Dri river was between NIZ & OT (37.8%) and least similarity was between DS & DSA (**Table 5.23**), which was adjacent and in the same habitat. From the resultant large dissimilarities of species among different impact zones, it is apparent that the microhabitats and niches along with the habitat at each of the sites identified for different project activity are important for the survival/existence of the spiders. Hence proper care in the form of creating abodes replicating the present existing conditions would be crucial for their long-term existence.

Table 5.23: Similarity Matrix (%) of spiders between different Impact Zones along Dri river in the Etalin HEP Study Area

Impact Zones	PH&C	DSA	DS	QS	DY	WB	CCO	OT	NIZ
PH&C	100								
DSA	29.8	100							
DS	14.7	13.5*	100						
QS	17.1	18.9	29.4	100					
DY	25.5	44	16.3	26.8	100				
WB	26.7	20.6	35.7	31.3	16.7	100			
CCO	18.8	24.2	26.7	31.3	22.5	20	100		
OT	21.3	36.4	18.8	25	36	19.4	27.6	100	
NIZ	23.8	34.2	32	34.6	40	28	28	37.8**	100

*Least Similarity, ** Highest similarity; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

Tangon River: Along the Tangon river, highest similarity of 35.4% was observed between DY & DSA, followed by W/B & DS and least was between CCO & QS (**Table 5.24**). However, in the present scenario all these habitats along this river are undisturbed, so types of vegetation found at the specific sites were similar, hence the high similarity. An interesting observation was very frequent records of *Mesida culta* and *Leucauge decorate* from these areas, hinting towards colonization by resilient species that have adapted to cohabiting alongside anthropogenic disturbances.

Table 5.24: Similarity Matrix (%) of Spiders between different Impact Zones along Tangon river in the Etalin HEP Study Area

Impact Zones	DSA	DS	QS	DY	WB	CCO	OT	NIZ
DSA	100							
DS	11.1	100						
QS	8.7	27.3	100					
DY	35.4**	22.9	19.4	100				
W/B	9.8	35.3	21.1	15.2	100			
CCO	20.8	22.9	7.5*	20.8	18.8	100		
OT	18.6	26.3	14.3	28.6	16.2	23.5	100	
NIZ	12.1	13.2	19.4	20.8	8.6	18.4	14.6	100

*Least Similarity, ** Highest similarity; PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zones

5.2.2.4 Moths

On the whole, 51 species of moths 45 genera (43 identified) from 12 families were recorded in and around the base camp, which are listed in the **Annexure 5.7**. As previously mentioned in the methods section, moths were surveyed from a very restricted area and the results have nonetheless been quite intensive. The high species richness within a restricted area clearly points to the possibility of much more diversity of this group in the study area.

Plate 5.2: Some of the Entomofaunal Species recorded from the Etalin HEP study area

Common Windmill

Eastern Purple Sapphire

Great Nawab

Veined Jay

Tawny Mime

Paris Peacock

Orthetrum taemiolatum

Orthetrum pruinosum

Orthetrum triangulare

Pantala flavescens

Theridula sp.

Leucauge celebesiana

Lymantria concolor

Dysphania militaris

5.2.3 Status of Herpetofauna

5.2.3.1 Amphibians

Within the study area, 14 species of amphibians belonging to 12 genera and six families were recorded. Ten species of amphibians were reported along both Dri and Tangon rivers (**Table 5.25**). Overall, the species richness was low, possibly as the entire monsoon season, the main active breeding period, was not covered for sampling due to time constraints of the rapid assessment.

Table 5.25. Taxonomic Richness of Amphibians in Etalin HEP Study Area

Study Sites	Number of		
	Family	Genera	Species
Dri River	4	9	10
Tangon River	5	9	10
Study Area	6	12	14

Richness of different Amphibian Groups

The amphibians reported from the study area belonged to six different major groups (**Annexure 5.8**). Among these, aquatic frogs (occupying pools & puddles of water) and tree frogs (occupying trees, bushes & grasses in moisture rich areas both forest & its edge), with four species each, were comparatively more common than other groups. The horned frog (prefer areas with leaf litter & humus) and pigmy frog (prefer moist areas with leaf litter and short grass with sparse herbs and shrubs) were represented by only one species each (**Table 5.26**).

The Dri River, the largest of the two rivers in the study area, harboured only five groups, with the aquatic frogs being richer (four species), closely followed by tree frogs. Along the Tangon River as well, amphibians were also represented by five groups, of which tree frogs (the most commonly observed group) were represented by three species (**Table 5.26**). Although, this data gives an indication about the groups present in the study area within the study period, sampling covering the entire monsoon season might reveal a different scenario.

Table 5.26. Richness Status of different Amphibian Groups

Groups	Dri River	Tangon River	Study Area
Toads	1	2	2
Aquatic Frogs	4	2	4
Horned Frogs	1	0	1
Ranid Frogs	1	2	2
Tree Frog	3	3	4
Pigmy Frog	0	1	1

5.2.3.2 Reptiles

A total of 31 species of reptiles, belonging to 23 genera and seven families, were observed in the study area. Among the two rivers, 26 species were observed along Dri, while 23 species were observed along Tangon river. (**Table 5.27**).

Table 5. 27: Taxonomic Richness of Reptiles in EHEP study area

Study Sites	Number of		
	Family	Genera	Species
Dri River	7	22	26
Tangon River	6	19	23
Study Area	7	23	31

Richness of different Reptilian Groups

The 31 species of reptiles recorded during this assessment (**Annexure 5.8**) fall under six different groups, with non-venomous snakes being the most frequently encountered group (17 species), followed by skinks and venomous snakes (five species each) (**Table 5.28**). The snakes are generally found in the sites with rocks crevices, dense ground cover, open patches with moisture and leaf litter, and other sites with cover and partially/completely sunlit before dusk.

All the six groups were recorded along the Dri River, while along the Tangon river, only five groups were recorded (except monitor lizard). Along both rivers, non-venomous snakes were the commonly observed group (**Table 5.28**).

Table 5.28: Richness Status of different Reptilian Groups

Groups	Dri	Tangon	Study Area
Agamid Lizards	2	1	2
Skinks	4	5	5
Monitor Lizard	1	0	1
Python	1	1	1
Non-venomous Snake	14	12	17
Venomous Snake	4	4	5
Total	26	23	31

5.2.3.3 Species of Conservation Significance

Species of conservation significance includes those listed, as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List for amphibians and reptiles (RET species), Schedule - I of Indian Wildlife Protection Act (1972), and endemic species to Arunachal Pradesh and North East India, where the main study area is located. Three species of conservation significance, were recorded in the study area namely, Bengal Monitor Lizard (*Varanus bengalensis*; Schedule I species – IWPA 1972), Burmese Python (*Python bivittatus*; Vulnerable - IUCN and Schedule I – IWPA 1972) and King Cobra (*Ophiophogus Hannah*; Vulnerable - IUCN). All three were reported only through social surveys within the study area (**Annexure 5.8)**

Plate 5.3: Some of the Herpetofaunal Species recorded from the Etalin HEP study area

Large Tree Frog

Stuart's Toad

Rock Skink

Spotted Litter Skink

Mountain Lizard

Jerdon’s Forest Lizard

	
Green Rat Snake	**Green Trinket Snake**
	
King Cobra	**Mock Viper**
	
Striped trinket snake	**Himalayan keelback**

5.2.4 Status of Birds

Based on inventory or listing of bird species, overall 230 species were recorded from the Etalin HEP study area (**Annexure 5.9**). However, the taxonomic richness, abundance status, foraging guild status and migratory status is dealt based on the quantitative information collected using point counts in both the basins. Since the vegetation was dense and detectability was less, birds were heard more than seen. In the following sections the quantitative data is used to describe the status of birds along both the Dri and Tangon Rivers, and the study area, through which the rivers are flowing.

a) *Taxonomic Richness and Diversity*

The total richness of species in the study area based on quantification was 87 species of 60 genera and 39 families, which were recorded at a low diversity of H'= 1.7. The birds from the two basins and the respective forest along the slopes, contributed to this richness of study area. The cumulative richness and diversity of the impact zones within the study area, showed a comparatively high richness in the Dam Submergence Area + Dam Site (DSA+DS) 33 species, and Non-impact Zone (NIZ) 31 species, while the diversity was high in NIZ and Other Area (OT) (**Table 5.29**).

Among the two river basins, more richness (48 species at a diversity of H'=1.3) was recorded in the Dri basin compared to the Tangon basin (39 species at a diversity of H'=1.1), which was less disturbed than the former (**Table 5.29**). In general, the richness and diversity of birds in the study area seem to be less, which is mainly due to the already continuing degradation and loss of habitat owing to the road expansion work along the Dri river and forests cleared as part of *Jhuming* cultivation and NFTP collection by the locals along the Tangon river. Further, in the areas with vegetation along both the rivers, the dense cover also influenced the visibility, in terms of poor detectability, which is probably also a reason for less richness.

Along Dri, Dam Submergence Area and Dam Site (DSA&DS) harboured more richness (26 species), followed by Camps, Colony and Office (CCO) and Workshops, Stores and Batching Plants (W/B), with least being in Dump Yard (DY). The diversity on the whole was less, with Quarry Site (QS) that recorded 10 species, reporting a comparatively more diversity (h'= 1.43) (**Table 5.29**), Thus showing that one or few species were dominant along this river, however a longer study would have probably shown the true scenario.

Richness in the impact zones along Tangon, showed more richness of 21 species in Other Areas (OT) followed by Non-impact Zone (NIZ). However, OT recorded comparatively more diversity (H'=1.79) (**Table 5.29**). On the whole along Tangon also the diversity was low revealing that birds present were dominated by one are few species.

Table 5.29: Richness and Diversity of Bird Species in Etalin HEP Study Area

Impact Zones	Dri River				Tangon River				Study Area			
	Fm	Gn	Sp	H'	Fm	Gn	Sp	H'	Fm	Gn	Sp	H'
PH&C	9.0	11.0	11.0	1.3	--	--	--	--	9.0	11.0	11.0	1.3
DSA+DS	19.0	19.0	26.0	1.2	12.0	13.0	15.0	1.0	22.0	25.0	33.0	1.1
QS	8.0	10.0	10.0	1.4	8.0	8.0	8.0	1.1	13.0	14.0	14.0	2.0
DY	5.0	6.0	6.0	1.2	12.0	11.0	12.0	1.2	13.0	15.0	16.0	1.8
W/B	14.0	16.0	21.0	1.4	7.0	13.0	15.0	1.0	19.0	24.0	29.0	1.2
CCO	16.0	19.0	22.0	1.4	8.0	9.0	10.0	1.1	19.0	25.0	29.0	1.9
OT	7.0	7.0	7.0	1.3	16.0	20.0	21.0	1.8	17.0	21.0	23.0	2.2
NIZ	12.0	14.0	16.0	1.3	17.0	19.0	20.0	1.6	21.0	26.0	31.0	2.1
TOTAL	33.0	40.0	48.0	1.3	31.0	34.0	39.0	1.1	39.0	60.0	87.0	1.7

Fm- Family, Gn – Genera, Sp – Species, H' – Shannon Diversity Index; PH&C-Power House and confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones

b) Abundance Status

The analysis of abundance of species was done through classifying the bird species based on the number of individuals sighted, into five different categories: Very Low (1-25), Low (26-50), Medium (50-75), High (76-100) and Very High (>100).

Dri River: The abundance status analysis showed that all the bird species recorded along the Dri river were found in very low to low abundance. The abundance status of birds in different impact zones showed very low abundance in all the zones, with Dam Submergence Area + Dam Site (DSA+DS) having low abundance compared to very low in other zones (**Table 5.30**). This poor abundance could probably be due to the existing disturbances prevailing along this river in the form of road construction/expansion, which is ongoing, that has led to loss of forest, in addition to detectability, as vegetation cover was dense, where ever present.

Table 5.30: Abundance categories, No. of species (Species Richnessand Relative (%) of Birds in different Impact Zones along Dri river

Impact Zones	No. of Species	R%
PH&C	very low (11)	100
DSA+DS	low (26)	100
QS	very low (10)	100
DY	very low (06)	100
W/B	very low (21)	100
CCO	very low (22)	100
OT	very low (07)	100
NIZ	very low (16)	100
TOTAL	very low (22)	45.8
	low (26)	54.2

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones; Very Low = 1-25 species, Low = 26-50 species

Tangon River: The abundance of birds recorded in different land acquisition for project-based activities along the Tangon river also showed that the abundance was very low across all the impact Zones (**Table 5.31**). The Tangon basin is relatively undisturbed from anthropogenic activity apart from the shifting cultivation and collection of NTFP from the forests. However, less species richness and abundance, indicates that the habitat although relatively undisturbed is not diverse enough to support different niches for diverse species, in addition to poor visibility that has influenced the detectability, due to dense vegetation cover.

Table 5.31: Abundance Categories, No. of species (Species Richness and Relative (%) of Birds in different Impact Zones along Tangon River

Impact Zones	No. of Species	R%
PH&C	-	-
DSA+DS	very low (15)	100
QS	very low (08)	100
DY	very low (12)	100
W/B	very low (15)	100
CCO	very low (10)	100
OT	very low (21)	100
NIZ	very low (20)	100
TOTAL	very low (37)	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, Colony and Offices; OT-Others; NIZ-Non-impact Zone: Very Low = 1-25 species

c) Foraging Guild Status of Birds

The foraging guild is based on the major food item the birds feed. The foraging guild gives information on the ecological services the bird species provide in an ecosystem.

Dri River: The foraging guild status of birds recorded along Dri river in the Etalin HEP study area, revealed that birds in the study area belonged to seven different guilds. Among these, most of the species recorded were insect feeders / insectivores (natural insect pest controllers (22 species / 45.8 %), followed by frugivores / fruit eaters (natural seed dispersers) and nectarivores / nectar feeders (natural pollinators) (**Table 5.32**). This also indirectly shows the type of habitat present in the area and whether it is flowering / fruiting season.

The analysis of foraging guild of birds in different impact zones along Dri, showed that in all the zone insectivores were dominant except for Quarry Site (QS), where nectarivores were more (**Table 5.32**). The reason was probably more trees in that QS site with flowers during the period of study, compared to other zones.

Table 5.32. Bird Species Richness and Relative (%) in different Foraging Guilds along Dri River

Impact Zones	Foraging guild							Total
	C	F	G	I	N	P	O	
PH&C								
Species Richness	0	1	0	8	0	1	1	11
Relative (%)	0.0	9.1	0.0	72.7	0.0	9.1	9.1	100
DSA +DS								
Species Richness	0	3	1	15	2	0	5	26
Relative (%)	0.0	11.5	3.8	57.7	7.7	0.0	19.2	100
QS								

Impact Zones	Foraging guild							Total
	C	F	G	I	N	P	O	
Species Richness	0	2	0	2	5	0	1	10
Relative (%)	0.0	20.0	0.0	20.0	50.0	0.0	10.0	100
DY								
Species Richness	0	2	0	3	1	0	0	6
Relative (%)	0.0	33.3	0.0	50.0	16.7	0.0	0.0	100
W/B								
Species Richness	1	4	0	10	4	0	2	21
Relative (%)	4.8	19.0	0.0	47.6	19.0	0.0	9.5	100
CCO								
Species Richness	2	5	0	7	3	0	5	22
Relative (%)	9.1	22.7	0.0	31.8	13.6	0.0	22.7	100
OT								
Species Richness	0	3	0	2	1	0	1	7
Relative (%)	0.0	42.9	0.0	28.6	14.3	0.0	14.3	100
NIZ								
Species Richness	1	5	0	7	2	0	1	16
Relative (%)	6.2	31.3	0.0	43.8	12.5	0.0	6.2	100
Study Area								
Species Richness	2	10	1	22	7	1	5	48
Relative (%)	4.2	20.8	2.1	45.8	14.6	2.1	10.4	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones; No. of Sp – Number of Species; Foraging Guild: C – Carnivore, F – Frugivore, G – Granivore, I – Insectivore, N – Nectarivore, P = Piscivore, O – Omnivore

Tangon River: The status of birds in different foraging guild along the Tangon river showed that this river also, harboured birds of seven foraging guilds, with insectivores being predominant, followed by Omnivores / feeding on both insects or flesh, and fruits or other plant parts (duel services – natural pest controller and natural seed disperser). This clearly indicates the low availability of flowers and to some extent the fruiting trees in the area. The poor representation of carnivores, granivores, piscivores (**Table 5.33**) shows the less or non-availability of the habitats for the birds of these guilds, which was mentioned as reason for poor richness and abundance along this river.

Table 5.33: Bird Species Richness and Relative (%) of in different Foraging Guilds along Tangon River

Impact Zones	Foraging guild							Total
	C	F	G	I	N	P	O	
PH&C								
Species Richness	0	0	0	0	0	0	0	0
Relative (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
DSA+DS								
Species Richness	0	2	0	8	0	0	5	15
Relative (%)	0.0	13.3	0.0	53.3	0.0	0.0	33.3	100
QS								
Species Richness	1	2	0	5	1	0	1	8
Relative (%)	12.5	25.0	0.0	62.5	12.5	0.0	12.5	100
DY								
Species Richness	0	1	0	10	3	0	2	12
Relative (%)	0.0	8.3	0.0	83.3	25.0	0.0	16.7	100
W/B								
Species Richness	0	1	0	10	2	1	2	15
Relative (%)	0.0	6.7	0.0	66.7	13.3	6.7	13.3	100
CCO								
Species Richness	1	0	1	6	0	0	2	10
Relative (%)	10.0	0.0	10.0	60.0	0.0	0.0	20.0	100
OT								
Species Richness	0	4	1	11	2	0	3	21
Relative (%)	0.0	19.0	4.8	52.4	9.5	0.0	14.3	100
NIZ								
Species Richness	1	3	0	9	1	0	6	20
Relative (%)	5.0	15.0	0.0	45.0	5.0	0.0	30.0	100
Study Area								
Species Richness	1	5	1	20	3	1	6	37
Relative (%)	2.7	13.5	2.7	54.1	8.1	2.7	16.2	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones; No. of Sp – Number of Species; Foraging Guild: C – Carnivore, F – Frugivore, G – Granivore, I – Insectivore, N – Nectarivore, P = Piscivore, O – Omnivore

Study Area: In the entire study area also, as in the case of both Dri and Tangon basins, insectivores (52 species/59.8% of species), were dominant among of the seven foraging guilds that were represented. This was followed by frugivores, but with only 13.8% of the total species recorded. Rest of the guilds were poorly represented (**Table 5.34**); however, their presences shows that these niches for these birds even if available could be either available in patches/is naturally low.

Table 5.34: Bird Species Richness and Relative (%) in different Foraging Guild in the Study Area

Impact Zones	Foraging Guild							Total
	C	F	G	I	N	P	O	
PH&C								
Species Richness	0	0	0	9	0	1	1	11
Relative (%)	0.0	0.0	0.0	81.8	0.0	9.1	9.1	100
DSA + DS								
Species Richness	0	0	1	20	4	0	8	33
Relative (%)	0.0	0.0	3.0	60.6	12.1	0.0	24.2	100
QS								
Species Richness	1	3	0	5	3	0	2	14
Relative (%)	7.1	21.4	0.0	35.7	21.4	0.0	14.3	100
DY								
Species Richness	0	2	0	10	2	0	2	16
Relative (%)	0.0	12.5	0.0	62.5	12.5	0.0	12.5	100
W/B								
Species Richness	1	6	0	14	3	1	4	29
Relative (%)	3.4	20.7	0	48.3	10.3	3.4	13.8	100
CCO								
Species Richness	3	6	1	10	4	0	5	29
Relative (%)	10.3	20.7	3.4	34.5	13.8	0	17.2	100
OT								
Species Richness	0	6	1	10	2	0	4	23
Relative (%)	0	26.1	4.3	43.5	8.7	0	17.4	100
NIZ								
Species Richness	2	6	0	15	6	0	2	31
Relative (%)	6.5	19.4	0	48.4	19.4	0	6.5	100
Study Area								
Species Richness	3	12	4	52	7	2	7	87
Relative (%)	3.4	13.8	4.6	59.8	8	2.3	8	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones; No. of S p – Number of Species; Foraging Guild: C – Carnivore, F – Frugivore, G – Granivore, I – Insectivore, N – Nectarivore, P = Piscivore, O – Omnivore

d) Migratory Status of Birds

The migratory status is detailed based on the season the birds visit the study area / when the birds were observed in the study area, within the seasons covered as part of this study.

Dri River: Along the Dri river, of the total 48 species of birds recorded, maximum (30 species) were residents forming 62.5 % of the total, followed by summer visitors (birds that were seen only in the summer season) and winter visitors (birds observed only during winter). Among the different impact zones, a similar scenario was observed with resident birds being more in all zones except for PH&C, where winter visitors were more (six species / 54.5%) than residents. Winter visitors were not recorded in DY, QS, OT and NIZ, while summer visitors were not recorded from PH&C and QS (**Table 5.35**). However, this might not be true, as the study was a rapid assessment and only for four months covering only parts of different seasons. But it is evident that the study area and both the rivers provide habitat, also for bird species that visit in different seasons, either for nesting (summer season visitors) or feeding (winter visitors).

Table 5.35. Migratory Status of Bird Species along Dri River

Impact Zones	Migratory Status			Total
	Residents	Summer Visitors	Winter Visitors	
PH&C				
Species Richness	5	0	6	11
Relative (%)	45.5	0.0	54.5	100
DSA+DS				
Species Richness	17	3	6	26
Relative (%)	65.4	11.5	23.1	100
QS				
Species Richness	10	0	0	10
Relative (%)	100.0	0.0	0.0	100
DY				
Species Richness	4	2	0	6
Relative (%)	66.7	33.3	0.0	100
W/B				
Species Richness	13	6	2	21
Relative (%)	61.9	28.6	9.5	100
CCO				
Species Richness	17	3	2	22
Relative (%)	77.3	13.6	9.1	100

Impact Zones	Migratory Status			Total
	Residents	Summer Visitors	Winter Visitors	
OT				
Species Richness	6	1	0	7
Relative (%)	85.7	14.3	0.0	100
NIZ				
Species Richness	12	4	0	16
Relative (%)	75.0	25.0	0.0	100
Study Area				
Species Richness	30	10	8	48
Relative (%)	62.5	20.8	16.7	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones

Tangon River: The birds recorded along the Tangon river also showed that the residents were more (21 species /56.8 % of species) followed by winter visitors and summer visitors. A similar trend was observed in all the impact zones (**Table 5.36**). However, this could not be the true scenario as the study was only for four months and did not cover all season fully. But from this it was evident that there were bird species visiting the habitats alongTangon river, vis-à-vis study area, in specific seasons.

Table 5.36. Migratory Status of Bird Species along Tangon River

Impact Zones	Migratory Status			Total
	Residents	Summer Visitors	Winter Visitors	
PH&C				
Species Richness	0	0	0	0
Relative (%)	0.0	0.0	0.0	0.0
DSA +DS				
Species Richness	10	0	5	15
Relative (%)	66.7	0.0	33.3	100
QS				
Species Richness	5	1	2	8
Relative (%)	62.5	12.5	25.0	100
DY				
Species Richness	6	0	6	12
Relative (%)	50.0	0.0	50.0	100
W/B				
Species Richness	7	5	3	15
Relative (%)	46.7	33.3	20.0	100

Impact Zones	Migratory Status			Total
	Residents	Summer Visitors	Winter Visitors	
CCO				
Species Richness	6	0	4	10
Relative (%)	60.0	0.0	40.0	100
OT				
Species Richness	9	7	5	21
Relative (%)	42.9	33.3	23.8	100
NIZ				
Species Richness	13	3	4	20
Relative (%)	65.0	15.0	20.0	100
Study Area				
Species Richness	21	6	10	37
Relative (%)	56.8	16.2	27.0	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones

Study Area: In the overall study area also, residents were more compared to the winter visitors and summer visitors. A similar scenario was observed in the case of diverse project land use / impact zones (**Table 5.37**). The reasons for the same was discussed above, but it is apparent that bird species composition various between seasons, due to some birds visiting the study area in specific seasons, and the availability of habitat and niche for these visitors. Further, this also indicated that a major proportion of the birds recorded in the study area are permanently residing in the area, thereby relying on the local resources to fulfil their basic needs. Therefore, habitat conservation and mitigation for habitat loss is of utmost importance for holistically safeguarding the environment as that would help ensure stable population trends for the avifauna in the long run.

Table 5.37: Migratory Status of Bird Species in the Study Area

Impact Zones	Migratory Status			Total
	Residents	Summer Visitors	Winter Visitors	
PH&C				
Species Richness	5	0	6	11
Relative (%)	45.5	0.0	54.5	100
DSA+DS				
Species Richness	20	3	10	33
Relative (%)	60.6	9.1	30.3	100
QS				
Species Richness	11	1	2	14

Impact Zones	Migratory Status			Total
	Residents	Summer Visitors	Winter Visitors	
Relative (%)	78.6	7.1	14.3	100
DY				
Species Richness	8	2	6	16
Relative (%)	50.0	12.5	37.5	100
W/B				
Species Richness	16	8	5	29
Relative (%)	55.2	27.6	17.2	100
CCO				
Species Richness	22	3	4	29
Relative (%)	75.9	10.3	13.8	100
OT				
Species Richness	14	6	3	23
Relative (%)	60.9	26.1	13.0	100
NIZ				
Species Richness	21	6	4	31
Relative (%)	67.7	19.4	12.9	100
Study Area				
Species Richness	52	16	19	87
Relative (%)	59.8	18.4	21.8	100

PH&C-Power House and Confluence; DSA-Dam Submergence Area; DS-Dam Site; QS-Quarry Site; DY-Dumping Yard; W/B- Workshops, Stores and Batching Plants; CCO- Camps, colony and Offices; OT-Others; NIZ-Non-impact zones

5.2.4.1 Bird Species Richness based on Inventory

Based on inventory or listing of bird species, overall 230 species were recorded from the Etalin HEP study area. Further, among these 230 species, 205 species were birds of terrestrial ecosystem, while the remaining 25 species were aquatic or dependent on aquatic ecosystem (**Annexure 5.9**).

5.2.4.2 Overall Species Richness

On the whole the cumulative richness of birds that are possible to occur in and around the Etalin HEP study area was 237 species of which 204 species were sighted exclusively during this study and seven species were reported only from (earlier study (EIA 2015). Remaining 26 species were common to this study as well as the list of 33 species collated from the existing report (EIA 2015) (**Annexure 5.9**).

5.2.4.3 Species of Conservation Significance

Species of conservation significance includes those listed, as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) in the IUCN Red List for Birds (RET species), Schedule - I of Indian Wildlife Protection Act (1972), and endemic species to Arunachal Pradesh and North East India, where the main study area is located.

In this category, there were five bird species among the total 87 species recorded in the study area, which were threatened, as these were listed as Schedule – I species of the Indian Wildlife Protection Action 1972. Among these species of conservation significance, three species were recorded from the Dri basin and three species from the Tangon basin, with Grey Peacock Pheasant (*Polyplectron bicalcaratum*) being present in both (**Table 5.38**). However, these were observed only once, based on which the habitat specifics for them within the study area cannot be conclusively deduced, as they are of varied foraging guilds and have varied habitat preferences (Ali & Ripley, 1988), it is important to conserve and preserve them. The habitat, features/characteristics present at the sites where these species were located needs to be established/replicated at the adjoining sites, if the original sites fall within the impact zones, or protected and preserved in the case of areas outside the impact zones.

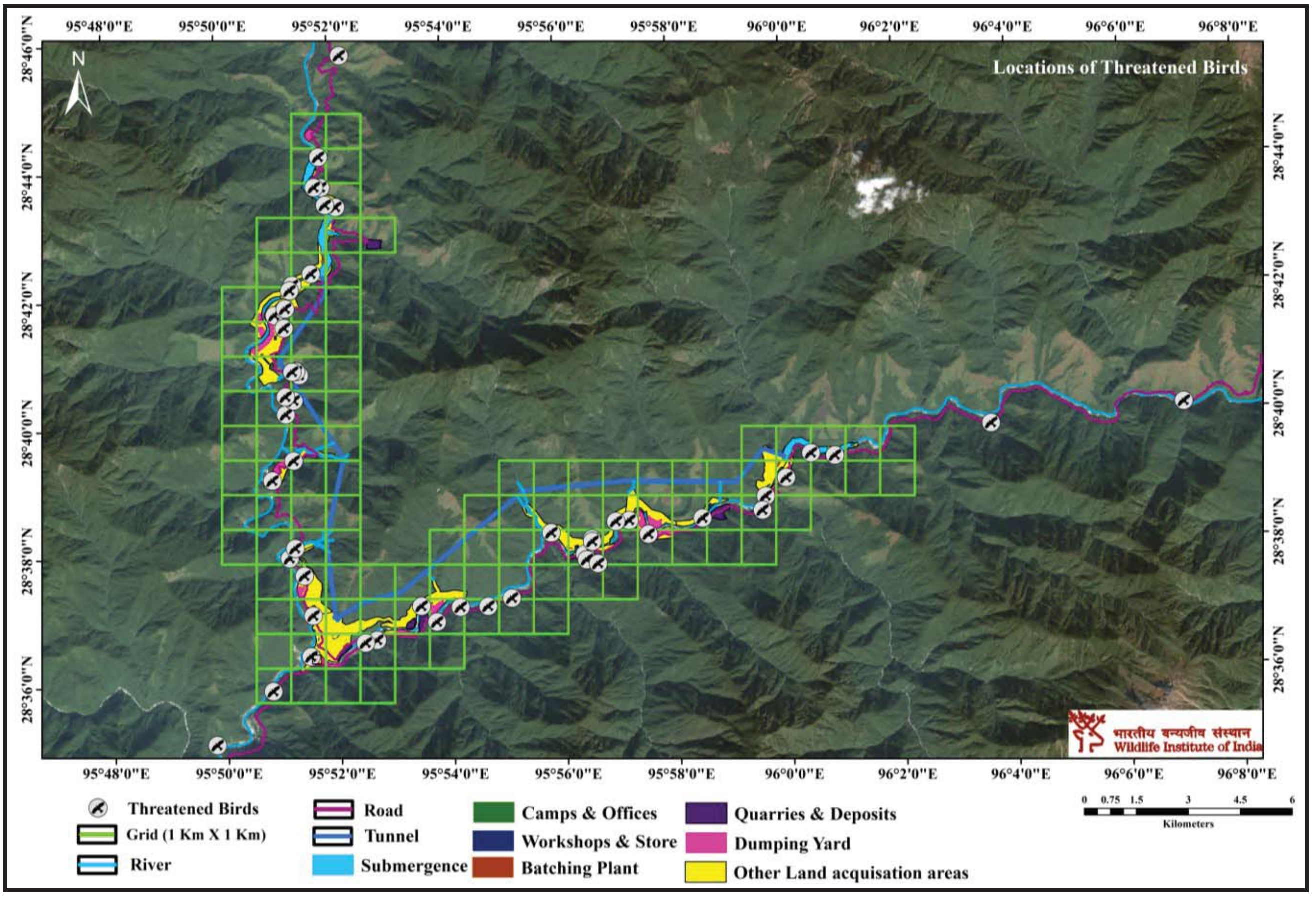
In addition to the above-mentioned species of conservation significance, there were seven more species that were listed as Near Threatened, in the IUCN Red List, which are birds, if their ecological needs are not taken care off, then they will also come into verge of extinction. So, any conservation and management plan suggested should also be ecologically beneficial also to these species (**Table 5.38**).

Endemic species: Of the 16 range restricted species of Eastern Himalayas (Stattersfield *et al.*, 1998), that are resident in Arunachal Pradesh, six species were sighted and recorded in the study area (**Tables 5.38**). The endemic species are of conservation significance, as these birds are found only in this region and have specific habitat features not found anywhere else and above all restricted to specific areas.

Of these four were present along the Dri river and all six species along Tangon river. Among these White-naped Yuhina (*Yuhina bakeri*) were sighted more frequently compared to others, followed by Yellow-vented Warbler (*Phylloscopus cantator*) (**Table 5.38**). White-naped Yuhina were sighted often in mixed flocks comprising of other yuhinas, warblers, fulvettas and babblers that have been recorded in the study area. Rest of the four were with one or two individuals. Hence, it is very crucial and critical to preserve these specific sites and the areas with these species, where some project activities have been planned, through establishing and replicating through restoration of habitat of these species and their conspecifics, in the adjoining areas. If the habitat is favourable, only then conspecifics that favour the presence of avifauna would be available, which would ensure their presence in the study area despite anthropogenic activities. Location of birds of conservation significance are shown on the map (**Map 5.7**).

Table 5.38. Bird Species of conservation significance recorded in the ZoI of Etalin HEP

S. No	Common Name (Scientific Name)	No. of Individuals			Schedule-I (IWPA 1972)	Endemic	IUCN (RET)
		Dri	Tangon	Study Area			
1	Crested Goshawk (*Accipiter trivirgatus*)	-	01	01	✓		
2	Eurasian curlew (*Numenius arquata*)	01	-	01			✓
3	Eurasian sparrowhawk (*Accipiter nisus*)	01	-	01	✓		
4	Grey peacock pheasant (*Polyplectron bicalcaratum*)	01	01	02	✓		
5	Himalayan vulture (*Gyps himalayensis*)	-	01	01			✓
6	Hoary throated barwing (*Actinodura nipalensis*)	01	01	02		✓	
7	Kalij pheasant (*Lophura leucomelanos*)	11	-	11	✓		
8	Rufous throated fulvetta (*Schoeniparus rufogularis*)	01	01	02		✓	
9	Rusty bellied shortwing (*Brachypteryx hyperythra*)	-	01	01		✓	✓
10	Shikra (*Accipiter badius*)	-	01	01	✓		
11	Striped tit babbler (*Mixornis gularis*)	01	-	01			✓
12	Ward's trogon (*Harpactes wardi*)	-	01	01		✓	✓
13	Wedge billed babbler (*Sphenocichla humei*)	01	-	01			✓
14	White naped yuhina (*Yuhina bakeri*)	08	10	18		✓	
15	Yellow rumped honeyguide (*Indicator xanthonotus*)	01	-	01			✓
16	Yellow vented warbler (*Phylloscopus cantator*)	07	02	09		✓	



Map 5.7: Location of Bird Species of Conservation Significance in Etalin HEP Study Area

Plate 5.4: Some of the Avifaunal Species recorded from the Etalin HEP study area

Maroon oriole

Streaked spiderhunter

	
Asian Emerald cuckoo	**Grey chinned minivet**
	
Black capped kingfisher	**Ferruginous flycatcher**
	
Dark sided flycatcher	**White naped yuhina**

	
Olive backed pipit	**Blue winged laughingthrush**
	
Cattle egret	**Chinese pond heron**
	
Spangled drongo	**Brown shrike**

	
Common hoopoe	**Oriental turtle dove**
	
Golden throated barbet	**Citrine wagtail**
	
Rufous breasted bushrobin	**Yellow throated fulvetta**

5.2.5 Status of Mammals

a) Species Richness

Within the ZoI, 21 species of mammals of 19 genera and 15 families was observed (**Table 5.39**). Of these, the camera trap method captured the presence of 14 species (under 12 genera and 12 families) along the Dri River and 17 species (under 15 genera and 13 families) along the Tangon river (**Plate 5.2**). Rest of the seven species were direct sightings. The estimates of species richness exclude an unidentified bat species and the Mithun (*Bos frontalis*), semi-wild cattle which is frequently seen in the forests areas as well as in and around the villages.

Table 5.39: Species Richness of Mammals in Dri and Tangon basins of Etalin HEP Study Area

Parameters	Dri	Tangon	Study area
Family	12	13	15
Genera	12	15	19
Species	14	17	21

b) Species Distribution

Species distribution estimates are based on the number of capture locations of a species through camera traps. In total, 14 species were captured 166 times (total capture) through camera traps. These captures occurred at 63 locations within the ZoI, with 32 locations (12 species) along the Dri River and 31 locations (10 species) along the Tangon River, thereby not showing variation in species distribution between the two rivers (**Table 5.40**).

In terms of relative species richness (R%; ratio of no. of capture locations of a species to total capture locations), four species (out of 14) namely, Indian Muntjac (19.0%), Yellow-throated Marten (17.5%), Himalayan Palm Civet (17.5%) and Leopard Cat (12.7%), showed the widest distribution within the study area. Their relative species richness values were higher than the mean relative species richness value of the study area (7.14%) and constituted 66.7% of the total capture locations (**Table 5.40**).

Table 5.40: Status of Mammalian Species Distribution within Etalin HEP Study Area

S. No	Species	Common name	Capture Frequency	No. of Locations			R%
				Dri	Tangon	SA	
1	*Capricornis thar*	Himalayan serow	4	4	-	4	6.4
2	*Cuon alpinus*	Indian wild dog	1		1	1	1.6
3	*Macaca assamensis*	Assam macaque	14	1	2	3	4.8
4	*Muntiacus gongshanensis*	Gongshan muntjac	2		2	2	3.2
5	*Muntiacus muntjak*	Indian muntjac	25	5	7	12	19.0
6	*Catopuma temmincki*	Asian golden cat	3	2	1	3	4.8

S. No	Species	Common name	Capture Frequency	No. of Locations			R%
				Dri	Tangon	SA	
7	*Prionailurus bengalensis*	Leopard cat	33	4	4	8	12.7
8	*Herpestes auropunctatus*	Small Indian mongoose	1	1		1	1.6
9	*Aherurus marcourus*	Brush tailed porcupine	4	1	1	2	3.2
10	*Manis pentadactyla*	Chinese pangolin	1	1		1	1.3
11	*Martes flavigula*	Yellow throated marten	32	5	6	11	17.5
12	*Sus scrofa*	Indian wild pig	2	2		2	3.2
13	*Ursus thibetanus*	Himalayan black bear	2	1	1	2	3.2
14	*Paguma larvata*	Himalayan palm civet	28	5	6	11	17.5
	Total		**166**	**32**	**31**	**63**	**100**
	Mean		**-**	**-**	**-**	**4.5**	**7.14**

c) Species abundance

Abundance values were calculated based on the capture frequency of a species using camera traps and were grouped into five abundance categories: very low (1-5 captures), low (6-10), medium (11-15), high (16-20) and very high (> 21). Along the Dri river, 10 species/71.4% of the species captured fall under the very low abundance category, while the remaining (4 species) fall under low (2 species) or medium category (2 species). Along the Tangon River, 12 species/70.6 % of the species captured had low abundance, however, the rest (five species) had medium to very high abundance values. Overall, within the study area, most of the species (15 species) fell under the low abundance category (71.4%) and only four species (<20%) had very high abundance values (**Table 5.41**).

Table 5.41: Abundance categories of mammalian species within the study area.

Abundance categories	Dri	R %	Tangon	R%	Study area	R%
Very Low (1-5 captures)	10	71.4	12	70.6	15	71.4
Low (6-10)	2	14.3	0	0.0	1	4.8
Medium (11 -15)	2	14.3	2	11.8	1	4.8
High (16-20)	0	0.00	1	5.8	-	-
Very High (> 21)	0	0.00	2	11.8	4	19.0
Total	**14**	**100**	**17**	**100**	**21**	**100**

Of the total number of species captured (21 species), in the study area five species namely, Leopard cat (*Prionailurus bengalensis:* 10 encounters in Dri and 23 in Tangon), Yellow throated marten

(*Martes flavigula* 11- Dri and 21- Tangon), Himalayan palm civet (*Paguma larvata*: 10- Dri and 18-Tangon) and Indian muntjac (*Muntiacus muntjak:* 13- Dri and 12- Tangon) were capture most frequently along both rivers. Rest of the species (76%) had very low abundance values and were captured less than 10 times by camera traps. Indian wild dog, Small Indian Mongoose, Chinese pangolin were captured only once in the camera traps (**Table 5.42**).

Table 5.42: Abundance Status of Mammalian species within Etalin HEP Study Area

S. No	Family and Scientific Name	Common name	No of captures			Nature of Record
			Dri	Tangon	SA	
Bovidae						
1	*Capricornis thar*	Himalayan serow	3	1	4	CT
Canidae						
2	*Cuon alpinus*	Indian wild dog	-	1	1	CT
Cercopithecidae						
3	*Macaca assamensis*	Assam macaque	3	11	14	CT /DS
Cervidae						
4	*Muntiacus gongshanensis*	Gongshan muntjac	-	2	2	CT
5	*Muntiacus muntjak*	Indian muntjac	13	12	25	CT /DS
Felidae						
6	*Catopuma temmincki*	Asian golden cat	2	1	3	CT
7	*Prionailurus bengalensis*	Leopard cat	10	23	33	CT/DS
Herpestidae						
8	*Herpestes auropunctatus*	Small Indian mongoose	1	-	1	CT
Hystricidae						
9	*Aherurus marcourus*	Brush tailed porcupine	2	2	4	CT
Manidae						
10	*Manis pentadactyla*	Chinese pangolin	1	-	1	CT
Muridae						
11	*Rattus nitidus*	Himalayan field rat		1	1	DS
Mustelidae						
12	*Lutrogale perspicillata*	Smooth coated otter	1	-	1	DS
13	*Martes flavigula*	Yellow throated marten	11	21	32	CT/DS
Sciuridae						

S. No	Family and Scientific Name	Common name	No of captures			Nature of Record
			Dri	Tangon	SA	
14	*Ratufa bicolor*	Black giant squirrel		**1**	**1**	**DS**
15	*Callosciurus pygerythrus*	Hoary-bellied Squirrel	2	5	7	DS
16	Callosciurus erythraeus	Pallas's squirrel	-	2	2	DS
17	*Tamiops macclellandi*	Himalayan Striped Squirrel	-	1	1	DS
Soricidae						
18	*Crocidura attenuate*	Asian grey shrew		1	1	DS
Suidae						
19	*Sus scrofa*	Indian wild pig	2	-	2	CT
Ursidae						
20	*Ursus thibetanus*	Himalayan black bear	1	1	2	CT
Viverridae						
21	*Paguma larvata*	Himalayan palm civet	10	18	28	CT
	Total Species		**14**	**17**	**21**	
	Total encounters		**62**	**104**	**166**	

CT-Camera Trap, DS – Direct Sightings.

Abundance based on total Camera Trap Nights: Abundance estimation was also done based on the capture rate (ratio of total captures to total camera trap nights). The estimation showed that, along both rivers (Dri = 0.14 and Tangon = 0.11) as well as within the study area (0.11), less than one capture or one species per 1552 trap nights was recorded, indicating very low abundance of mammals in the study area (**Table 5.43**).

Table 5.43. Abundance Status of Mammals based on Camera Trap Nights within Etalin HEP Study Area

Sampling area	Total Camera trap nights	Total capture	Capture rate
Dri River	430	62	0.144
Tangon River	981	104	0.106
Confluence	141	-	-
Total	**1552**	**166**	**0.106**

d) Checklist of Mammal

The checklist for mammals within the study area (**Annexure 5.10)** was prepared by including the species observed in the present study and those reported by secondary sources. The list of species recorded during the study was based on mammal survey (direct sightings and camera trap study) and those documented through interviews with local people with the help of field guides (Menon 2014). Social surveys resulted in a list of 34 species, out of which 12 species were excluded since they were restricted to upper reaches, which fall outside the study area (**Table 5.44**).

List of species documented via secondary sources includes species report in the EIA report (2015). Among all mammals list in EIA report, those occurring at higher altitudes outside the study area and/or are unlikely to occur in the study area were excluded. Mammal species mentioned in the Dibang Wildlife Sanctuary management plan were not included in the checklist as the sanctuary has a large geographic area (4149 km^2) and is spread across a higher altitudinal range (1800 – 5000m), which is located far from the outer boundary of the study area (crow fly distance > 10km).

Finally, the resulting checklist of mammals within the study area contains a total of 29 species belonging to 26 genera and 17 families (**Table 5.44 & Annexure 5.10**).

Table 5.44: Overall Mammal Species Richness within Etalin HEP Study Area

Status	Present Study		Study List	Secondary Source (EIA 2015)	Overall
	Mammals Survey	Social Survey			
Families	15	11	16	10	17
Genera	20	20	24	10	26
Species	22	22	27	11	29

e) Species of conservation significance

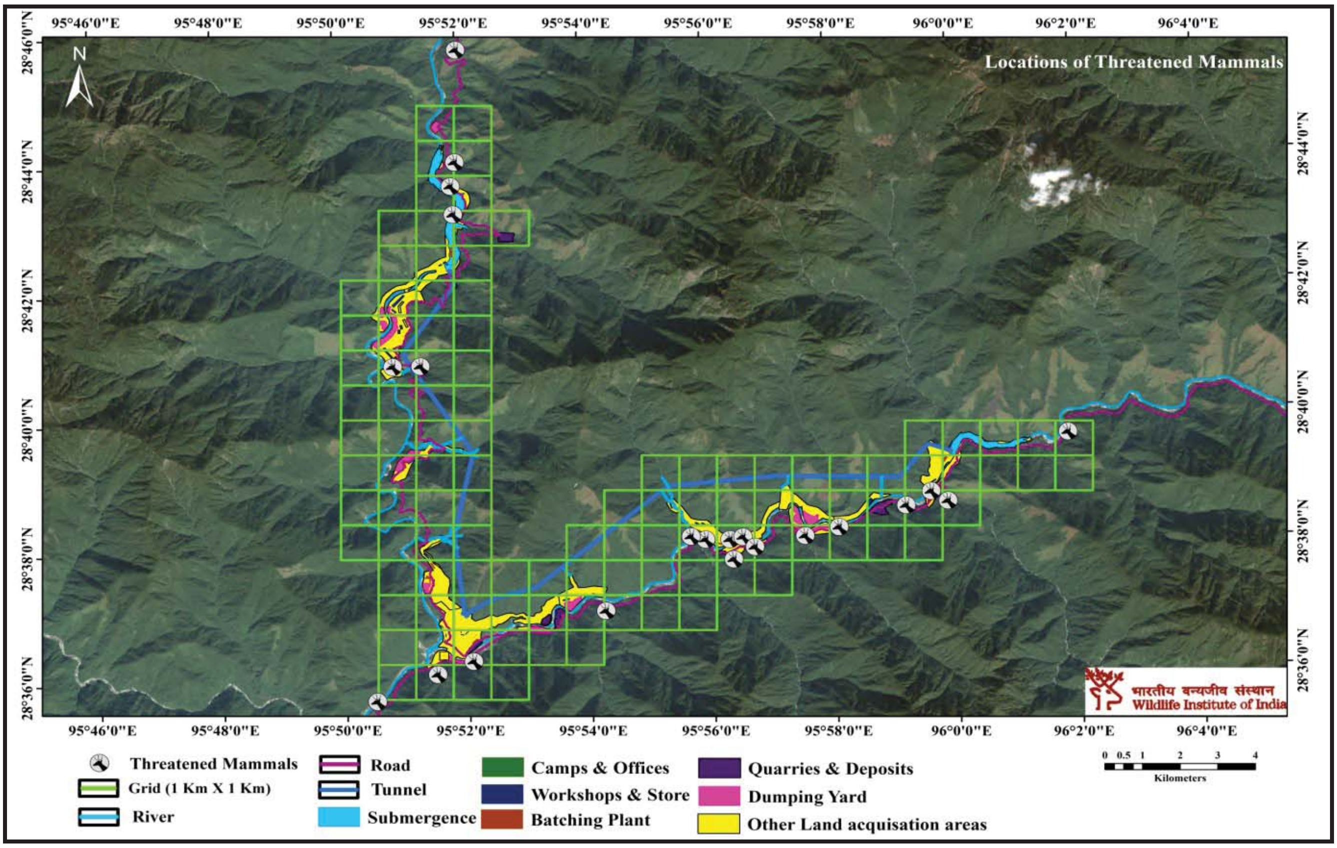
Out of 21 mammals recorded in the study area, five species are listed as threatened under different categories of the IUCN Red list (**Table 5.45**). Of these, one species is Critically Endangered (CR), one Endangered (EN), two Vulnerable and one species is Near Threatened. Three species, Himalayan serow-*Capricornis thar,* Asian golden cat- *Catopuma temmincki* and Leopard cat *Prionailurus bengalensis*, were listed as Schedule I of the Indian Wildlife Protection Act (IWPA, 1972).

Despite the low abundance values of the eight species of conservation significance within the study area (**Table 5.45**), their mere presence commands dedicated conservation efforts within the study area as well as within the Dibang valley. Locations of mammal species of conservation significance are shown in the **Map 5.8**.

Table 5.45: Status of Species of Conservation Significance within Etalin HEP Study Area.

S. No	Scientific Name	No. of Captures	Capture Rate	Conservation significance	
				IUCN	IWPA
1	*Capricornis thar* Himalayan serow	04	0.002	-	Sch I
2	*Cuon alpinus* Indian wild dog	01	0.0006	EN	-
3	*Macaca assamensis* Assam macaque	14	0.009	NT	-
4	*Catopuma temmincki* Asiatic golden cat	03	0.001	-	Sch I

S. No	Scientific Name	No. of Captures	Capture Rate	Conservation significance	
				IUCN	IWPA
5	*Prionailurus bengalensis* Leopard cat	33	0.02	-	Sch I
6	*Manis pentadactyla* Chinese pangolin	01	0.0006	CR	-
7	*Lutrogale perspicillata* Smooth coated otter	01	0.0006	VU	-
8	*Ursus thibetanus* Himalayan black bear	02	0.001	VU	-
	Total	**61**		**5**	**3**



Map 5.8: Location of Mammal Species of Conservation Significance in Etalin HEP Study Area

However, as mentioned before, secondary sources listed 10 mammal species that are unlikely to occur within the study area, it is essential that long-term monitoring and conservation efforts are planned particularly for species of conservation significance (**Table 5.46)** such as Mishmi Takin (endemic species), Alpine Musk Deer, Red goral, Clouded Leopard, Snow Leopard, Spotted Linsang, in and around the study area.

Table 5.46: Mammal Species of Conservation Significance in upper reaches of Dibang Valley

S. No	Scientific name	Common name	Conservation significance	
			IUCN	IWPA
1	*Ailurus fulgens*	Red panda	EN	Sch I
2	*Budorcas taxicolor taxicolor*	Mishmi Takin[E]	VU	Sch I
3	*Moschus chrysogaster*	Alpine Musk Deer	EN	Sch I
4	*Naemorhedus baileyi*	Red goral	VU	-
5	*Neofelis nebulosi*	Clouded Leopard	VU	Sch I
6	*Panthera pardus*	Common Leopard	VU	Sch I
7	*Panthera tigris*	Bengal tiger	EN	Sch I
8	*Panthera unsia*	Snow Leopard	VU	Sch I
9	*Pardofelis marmorata*	Marbled cat	NT	Sch I
10	*Prionodon pardicolor-*	Spotted Linsang	-	Sch I

IUCN: EN – Endangered, VU - Vulnerable, NT – Near Threatened; [E] Endemic species

Plate 5.5: Some of the Mammalian Fauna captured in the Camera Traps

Asiatic Black Bear

Himalayan Serow

Asiatic Golden Cat

Indian Wild Dog

Himalayan Palm Civet

Indian Wild Pig


Yellow Throated Marten

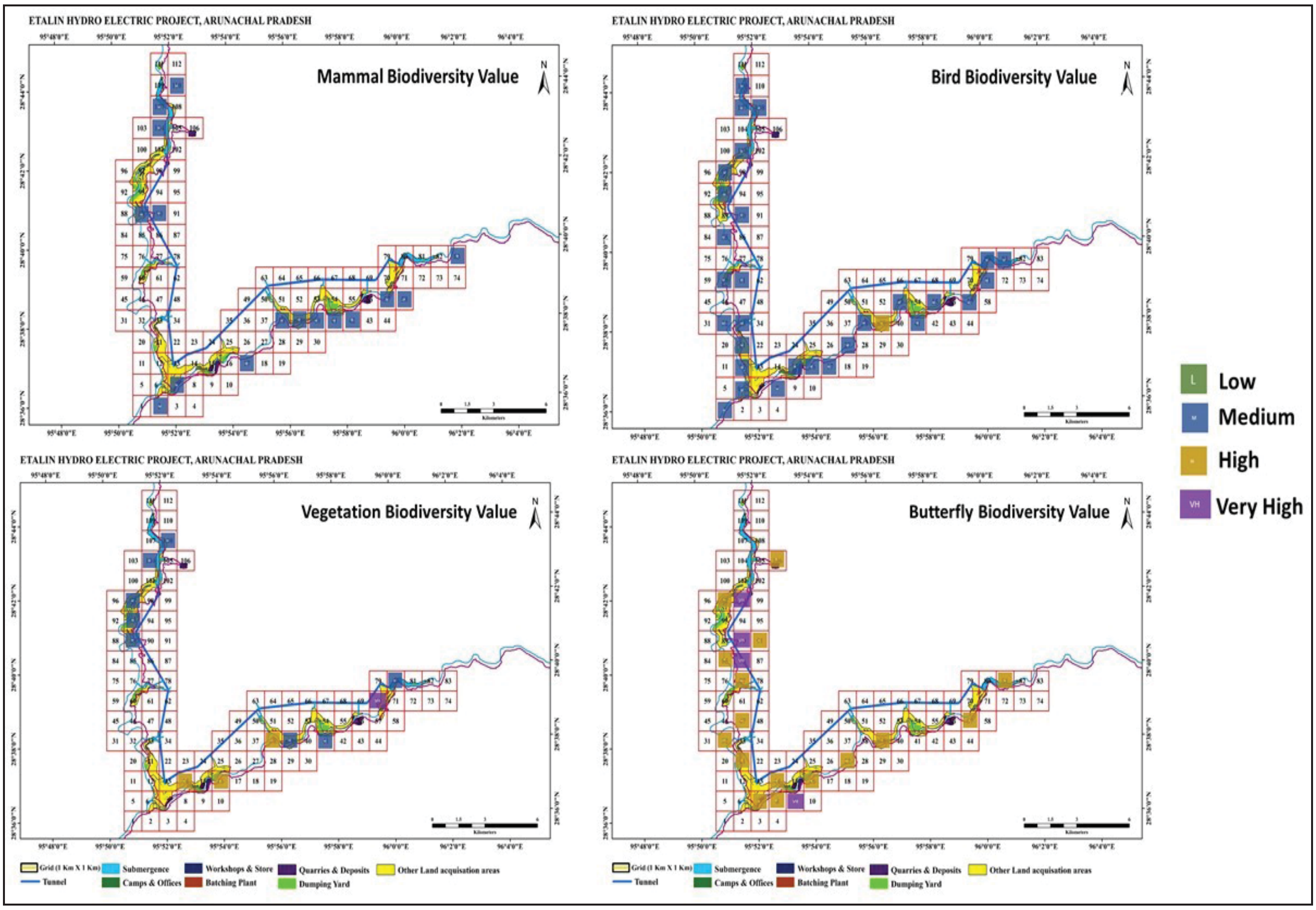
Barking Deer

Chinese Pangolin


Chinese Pangolin – Zoomed Image

5.2.6 Terrestrial Biodiversity Values of Etalin HEP Study Area

The biodiversity value for mammals, birds, butterfly and vegetation was assessed on the basis of richness of species of conservation significance, threatened (RET) and endemic species. Both Dri and Tangon basin has mostly medium mammal and bird biodiversity values, except for grid 39 in Tangon basin which has high bird biodiversity value due to the presence of highest number of RET species (4 out of 12). With respect to vegetation, the Dri basin had medium biodiversity values while very high and high values were restricted to the Tangon basin, close to the confluence and the proposed dam location. Biodiversity values related to butterflies were mostly high and very high in nature in both Dri and Tangon basins (**Map 5.9 a, b, c, d**).



Map 5.9: Grid-based Terrestrial Biodiversity values within the Study Area – a) Mammal Biodiversity Value, b) Bird Biodiversity Value, c) Vegetation Biodiversity Value & d) Butterfly Biodiversity Value

5.3 Aquatic Biodiversity

5.3.1 Habitat Quality

The channel morphology, meso-habitat composition and water chemistry variables varied along and among Dri and Tangon basins (**Table 5.47**). In general, within the study area, the average width ranged from 5.5 to 66 m, the average depth ranged from 0.12 m to 0.84 m (mostly measured along river banks), and the average flow velocity ranged between 0.50 to 2.63 m/s.

Among water chemistry variables, water temperature varied between 10 -17.6 ^{0}C, dissolved oxygen (DO) levels ranged from 7.9 mg/l to 12.3 mg/l, and specific conductance varied from 40.10 (S/m) to 151.2 (S/m). Similar mean water temperatures were recorded within the Dri basin (12.48 ± 1.81 [standard deviation, SD]) and Tangon basin (12.50 ± 1.90 SD). For DO as well, mean vales were similar in both Dri (9.48 ± 1.06 SD) and Tangon basins (9.76 ± 1.00 SD). On the other hand, higher mean flow velocities were recorded in Tangon basin (1.35 ± 0.75 SD) than in Dri basin (0.96 ± 0.48 SD) (**Table 5.47**).

Table 5.47: Stream Habitat characteristics and Water Chemistry Variables sampled in Dri, Tangon and Overall basin of Etalin HEP Study Area

Variables	Dri basin				Tangon basin				Overall			
	Mean	Min	Max	SD	Mean	Min	Max	SD	Mean	Min	Max	SD
Width (m)	41.8	4.0	118.0	39.4	28.1	5.5	66.0	20.6	25.2	5.5	66.0	20.6
Depth (m)	0.5	0.2	0.7	0.2	0.5	0.2	0.8	0.2	0.5	0.1	0.8	0.2
WT (°C)	12.5	9.6	17.2	1.8	12.3	10.2	14.3	1.2	12.5	10.1	17.6	1.9
pH	5.6	5.1	7.4	0.6	5.6	4.9	6.4	0.5	5.7	4.9	6.4	0.5
DO (mg/l)	9.5	7.3	11.0	1.1	9.8	8.4	12.3	1.0	9.6	8.0	12.3	1.1
SC (S/m)	53.0	30.0	121.0	25.4	64.6	40.1	100.4	17.7	68.8	40.1	151.2	28.7
EC (S/m)	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
Flow (m/s)	1.0	0.3	1.8	0.5	1.3	0.5	2.6	0.7	1.4	0.5	2.6	0.8
Riparian cover (%)	20.7	0.0	90.0	35.0	16.9	0.0	90.0	30.2	19.8	0.0	90.0	29.5
Bedrock (%)	27.7	0.0	70.0	17.4	33.0	0.0	70.0	17.3	30.6	0.0	70.0	17.3
Boulders (%)	31.9	0.0	60.0	12.8	34.2	0.0	50.0	13.2	31.7	0.0	50.0	14.1
Cobbles (%)	15.0	0.0	30.0	9.1	12.1	5.0	40.0	10.9	13.1	5.0	40.0	10.5
Pebbles (%)	6.2	0.0	20.0	6.2	3.2	0.0	10.0	4.3	5.4	0.0	20.0	7.1
Gravels (%)	8.1	0.0	20.0	6.6	11.5	5.0	50.0	11.9	13.3	5.0	50.0	12.2
Sand (%)	6.2	0.0	20.0	6.2	5.3	0.0	10.0	3.8	4.6	0.0	10.0	4.0
Leaf litter (%)	5.0	0.0	30.0	8.7	0.8	0.0	5.0	1.9	1.3	0.0	10.0	3.0

WT: Water temperature, DO: Dissolved oxygen, SC: Specific conductivity, EC: Electrical conductivity

5.3.2 Richness and Diversity of Fishes and Benthic Invertebrates

5.3.2.1 Benthic Invertebrate Richness

The micro-invertebrate community play a key role in structuring stream community and immensely contribute to the functioning of the stream ecosystem. One of the major roles of this community is leaf litter processing in the energy flow system. Most of the benthic invertebrate living in stream ecosystem are larval form of many terrestrial insects like Mayfly, Stonefly, Caddis fly, Odonates, Dipterans etc. These larval forms spend nearly few months to two years in the stream ecosystem and provide immense services to aquatic ecosystem. The abundance of macro-invertebrate community in stream ecosystem, mainly depends on physical and chemical properties, water quality and diversity of substrate composition. Among the micro-invertebrate communities, some group live in clear water with good water quality condition, they are called 'pollution sensitive species.' Similarly, some species thrive well in degraded and nutrient rich environment, they are called 'pollution tolerant' species. Because of their extended residency period in specific habitats and presence or absence of particular benthic species in a particular environment, these can be used as bio-indicators of specific environment and habitat conditions.

Total 17 groups of benthic invertebrates were identified during winter and pre-monsoon sampling. The macro-invertebrate fauna recorded during the survey in the study area are from ten Orders viz. Ephemeroptera, Trichoptera, Diptera, Coleoptera, Plecoptera, Hemiptera, Coleoptera, Dermoptera, Magoloptera, and Odonata (**Plate 5.3**). Among these, during winter season, 15 species of macro-invertebrate were recorded along Tangon river and 13 species along Dri river (**Figure 5.1a**). In both the rivers, Ephimeroptera, Plecoptera and Tricoptera were dominant over the rest of the groups. In the case of pre-monsoon season, 12 and 13 species of macro-invertebrate taxa were recorded in Tangon and Dri respectively (**Figure 5.1b**). Site wise distributions of EPT taxa across 27 sampling location covering winter and pre-monsoon seasons are also presented in **Figures 5.1a & b**. List of macro-invertebrate taxa recorded along the Dri and Tangon regions covering winter and pre-monsoon seasons are presented in **Table 5.48 and 5.49.**

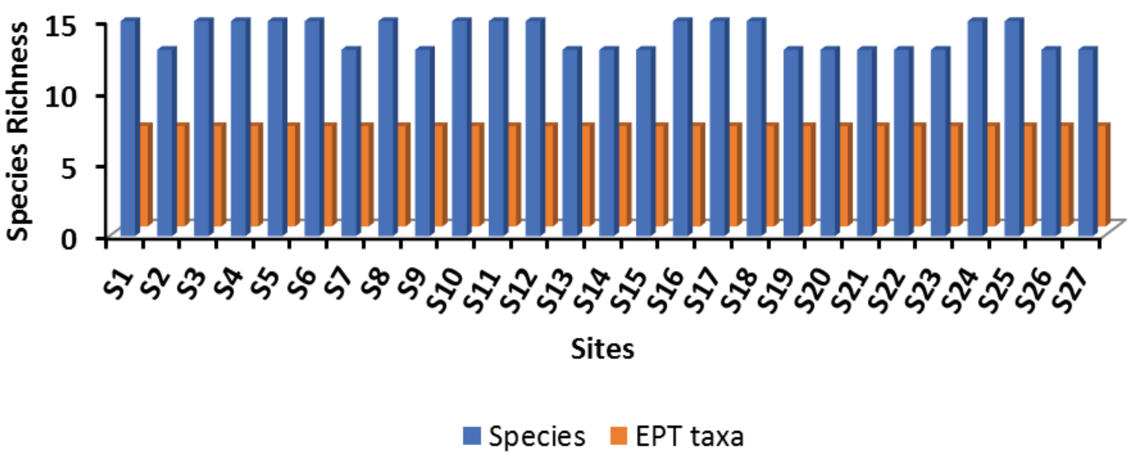


Figure 5.1a: Site wise number of macro-invertebrate species recorded during winter season [S1 – Anon Pani- Tango; S2 – Ayo Pani- Dri; S3 – Tangon-Submergence; S4- Shu pani- Tangon; S5 - achali bastinala – Tangon; S6 - Makri paninala - Tangon; S7 – Dri Main; S8 – Dri & Tangon confluence; S9 - chambo pani – Dri; S10 - Tangon near power house; S11 - Noh nala – Tangon; S12 - Mayo pani – Tangon; S13 - kabo pani – Dri; S14 – Dri submergence 1; S15 - Ru pani – Dri; S16 - Chan nala – Tangon; S17 - Tangon submergence 1; S18 - Tangon submergence 2; S19 - Inu pani – Dri; S20 - Ari pani – Dri; S21 - Dri submergence 2; S22 – Aro Pani – Dri; S23 – Emi pani – Dri; S24 – Tangon project area; S25 - Tangon project area; S26 – Dri end of submergence; 27 – Dri dam axis]

Table 5.48: List of Macro-invertebrate Taxa recorded along the Dri and Tangon Rivers during Winter Season

Family name	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27
Gomphidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydropsychedae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tipulidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Aphelocheiridae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gyrinidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Perlidae	+	-	+	+	+	+	-	+	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	+	+	-	-
Carcinophoridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corydalidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lepidostomatidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Stemopsychidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nemouridae	-	+	-	-	-	-	+	-	+	-	-	-	+	+	+	-	-	-	+	+	+	+	+	-	-	+	+
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Heptageniidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ephemerilidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Simulidae	+	-	+	+	+	+	-	+	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	+	+	-	-
Elmidae	+	-	+	+	+	+	-	+	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	+	+	-	-
Lestidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Species Richness	15	13	15	15	15	15	13	15	13	15	15	15	13	13	13	15	15	15	13	13	13	13	13	15	15	13	13
EPT taxa	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

S1 – Anon Pani- Tango; S2 – Ayo Pani- Dri; S3 – Tangon-submergance; S4- Shu pani- Tangon; S5 - achali bastinala – Tangon; S6 - Makri paninala - Tangon; S7 – Dri Main; S8 – Dri & Tangon confluence; S9 - chambo pani – Dri; S10 - Tangon near power house; S11 - Noh nala – Tangon; S12 - Mayo pani – Tangon; S13 - kabo pani – Dri; S14 – Dri submergence 1; S15 - Ru pani – Dri; S16 - Chan nala – Tangon; S17 - Tangon submergence 1; S18 - Tangon submergence 2; S19 - Inu pani – Dri; S20 - Ari pani – Dri; S21 - Dri submergence 2; S22 – Aro Pani – Dri; S23 – Emi pani – Dri; S24 – Tangon project area; S25 - Tangon project area; S26 – Dri end of submergence; 27 – Dri dam axis

Table 5.49: List of Macro-invertebrate Taxa recorded along the Dri and Tangon Rivers during Pre-monsoon Season

Family name	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S19**	**S20**	**S21**	**S22**	**S23**	**S24**	**S25**	**S26**	**S27**
Gomphidae	-	+	-	-	-	-	+	-	+	-	-	-	+	+	+	-	-	-	+	+	+	+	+	-	-	+	+
Hydropsychedae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tipulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aphelocheiridae	-	+	-	-	-	-	+	-	+	-	-	-	+	+	+	-	-	-	+	+	+	+	+	-	-	+	+
Gyrinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perlidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carcinophoridae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Corydalidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lepidostomatidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Stemopsychidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nemouridae	+	-	+	+	+	+	-	+	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	+	+	-	-
Baetidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Heptageniidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ephemerilidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Simulidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Elmidae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lestidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Species Richness	12	13	12	12	12	12	13	12	13	12	12	12	13	13	13	12	12	12	13	13	13	13	13	12	12	13	13
EPT taxa	8	7	8	8	8	8	7	8	7	8	8	8	7	7	7	8	8	8	7	7	7	7	7	8	8	7	7

S1 – Anon Pani- Tango; S2 – Ayo Pani- Dri; S3 – Tangon-submergance; S4- Shu pani- Tangon; S5 - achali bastinala – Tangon; S6 - Makri paninala - Tangon; S7 – Dri Main; S8 – Dri & Tangon confluence; S9 - chambo pani – Dri; S10 - Tangon near power house; S11 - Noh nala – Tangon; S12 - Mayo pani – Tangon; S13 - kabo pani – Dri; S14 – Dri submergence 1; S15 - Ru pani – Dri; S16 - Chan nala – Tangon; S17 - Tangon submergence 1; S18 - Tangon submergence 2; S19 - Inu pani – Dri; S20 - Ari pani – Dri; S21 - Dri submergence 2; S22 – Aro Pani – Dri; S23 – Emi pani – Dri; S24 – Tangon project area; S25 - Tangon project area; S26 – Dri end of submergence; 27 – Dri dam axis

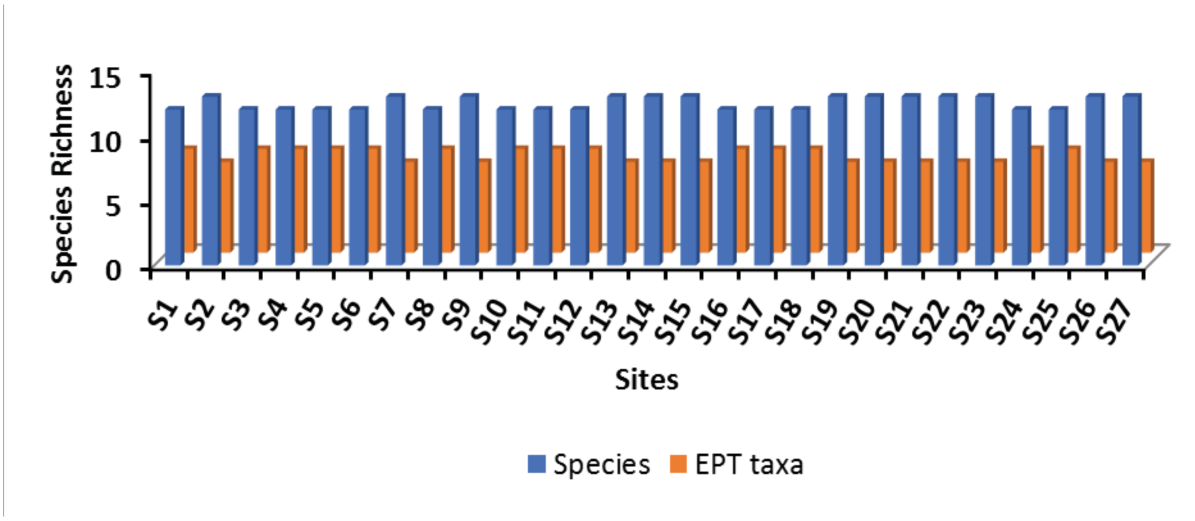


Figure 5.1 b: Site wise number of macro-invertebrate species recorded during pre-monsoon season [S1 – Anon Pani- Tango; S2 – Ayo Pani- Dri; S3 – Tangon-submergance; S4- Shu pani-Tangon; S5 - achali bastinala – Tangon; S6 - Makri paninala - Tangon; S7 – Dri Main; S8 – Dri & Tangon confluence; S9 - chambo pani – Dri; S10 - Tangon near power house; S11 - Noh nala – Tangon; S12 - Mayo pani – Tangon; S13 - kabo pani – Dri; S14 – Dri submergence 1; S15 - Ru pani – Dri; S16 - Chan nala – Tangon; S17 - Tangon submergence 1; S18 - Tangon submergence 2; S19 - Inu pani – Dri; S20 - Ari pani – Dri; S21 - Dri submergence 2; S22 – Aro Pani – Dri; S23 – Emi pani – Dri; S24 – Tangon project area; S25 - Tangon project area; S26 – Dri end of submergence; 27 – Dri dam axis]

Percentage Composition of EPT (Clean Water Species)

Based on the distribution of various groups of benthic invertebrates, percentage composition of the clean water species such as Ephimeroptera, Plecoptera and Tricoptera were estimated for each site. During winter season, the percentage of EPT, varied between 47 and 54, whereas in pre-monsoon season it ranges from 54 to 67 percentages (**Figure 5.2**). Generally, the percentage composition of EPT being more than 60% than the rest of the group, indicate clean water condition, which is more ideal for colonization of pollution sensitive species (EAP, 1997). The reduction in percentage composition of EPT when compared to rest of the groups, indicates the streams are under varying level of degradation. The important factors reducing the quality of stream water are: siltation due to dumping debris and construction materials in to river channel, surface run off from agricultural/ horticultural field, discharging household drainage and other man-made activities in the upstream area. Further, the assemblage structure of macro-invertebrate community recorded in the study area may change due to pre and post dam construction activities along the Dri and Tanglon river.

Plate 5.6: Macro-invertebrates recorded from Etalin HEP Study Area		
		
Trichoptera: Hyderopsychedae	**Coleoptera: Gyrinidae**	**Ephemeroptera: Heptageniidae**
		
Ephemeroptera: Baetidae	**Plecoptera: Perlidae**	**Hemiptera: Aphelocheiridae**
		
Megaloptera: Corydalidae	**Odonata: Gomphidae**	**Coleoptera, Elmidae**

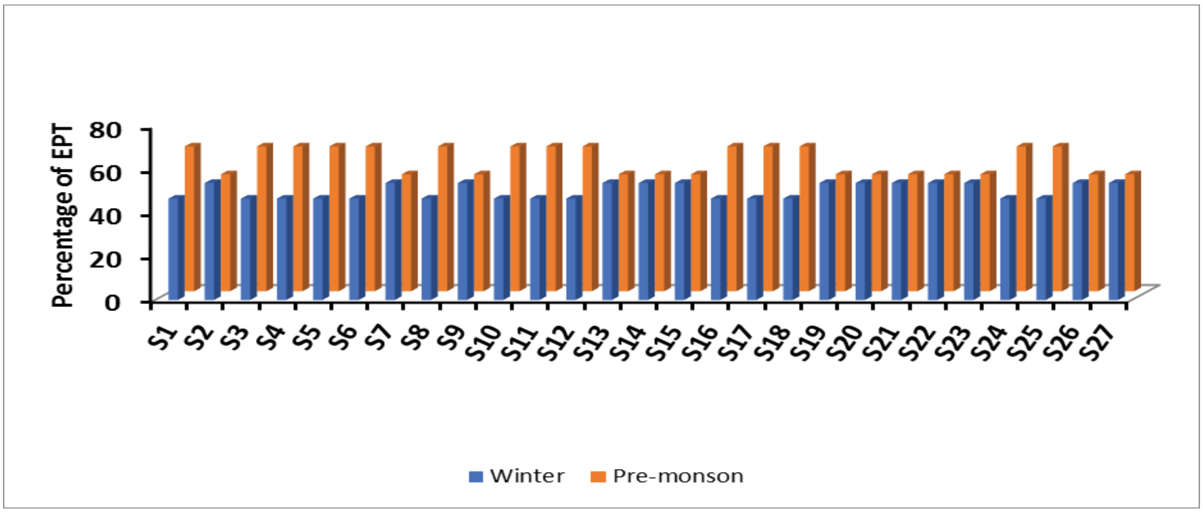
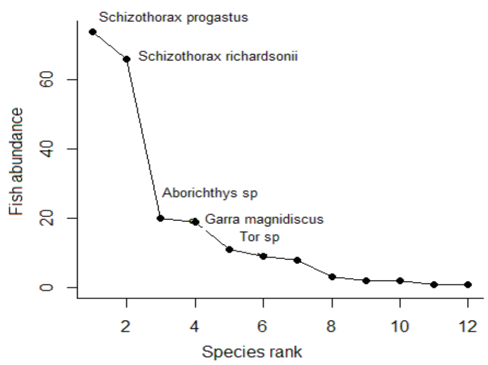


Figure 5.2. Percentage composition of EPT taxa recorded in winter and pre-monsoon season in Dri and Tangon rivers [S1 – Anon Pani- Tango; S2 – Ayo Pani- Dri; S3 – Tangon-submergance; S4- Shu pani- Tangon; S5 - achali bastinala – Tangon; S6 - Makri paninala - Tangon; S7 – Dri Main; S8 – Dri & Tangon confluence; S9 - chambo pani – Dri; S10 - Tangon near power house; S11 - Noh nala – Tangon; S12 - Mayo pani – Tangon; S13 - kabo pani – Dri; S14 – Dri submergence 1; S15 - Ru pani – Dri; S16 - Chan nala – Tangon; S17 - Tangon submergence 1; S18 - Tangon submergence 2; S19 - Inu pani – Dri; S20 - Ari pani – Dri; S21 - Dri submergence 2; S22 – Aro Pani – Dri; S23 – Emi pani – Dri; S24 – Tangon project area; S25 - Tangon project area; S26 – Dri end of submergence; 27 – Dri dam axis]

5.3.2.2 Fish Richness

Overall, 12 different species of fishes (belonging to two orders and four families) were recorded within the study area over the sampling period. Overall, *Schizothorax progastus* was the most dominant species (34.3%), followed by *S. richardsonii* (30. 6%), *Aborichthys* sp (9.3 %,), *Garra magnidiscus* (8.8%), *Tor* sp (5 %) (**Table 5.50 & Figure 5.3a**). Of the two orders, the most dominant was Cypriniformes with eight species (94%) as compared to four species (6%) in Siluriformes. As for families, Cyprinidae (carps, minnows) was the most dominant (five species), followed by Sisoridae (four species), Nemacheilidae (two species) and Psilorhynchidae (one species) (**Table 5.50 & Figure 5.3b**).



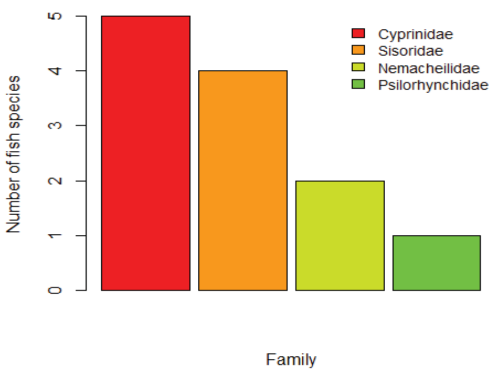


Figure 5.3: a). Overall species rank abundance plot shows, *Schizothorax progastus* was most dominant species followed by *S. richardsonii*, *Aborichthys* sp, *Garra magnidiscus* and *Tor* sp. b) Family wise richness was well represented by Cyprinidae followed by Sisoridae

In Dri sub-basin, five most dominant species were *Schizothorax progastus* followed by *S. richardsonii*, *Exostoma labiatum*, *Garra kempi* and *G. magnidiscus* while, in Tangon basin, *S. richardsonii* dominated than *S. progastus*, *Aborichthys* sp, *Garra magnidiscus* and *Tor* sp (**Figures 5.4 a & b**). This suggest that, the fish community belong to cold-water and headwater specialist category. These fishes complete their life-cycle within available narrow thermal tolerance and flow range (Sehgal 1999).

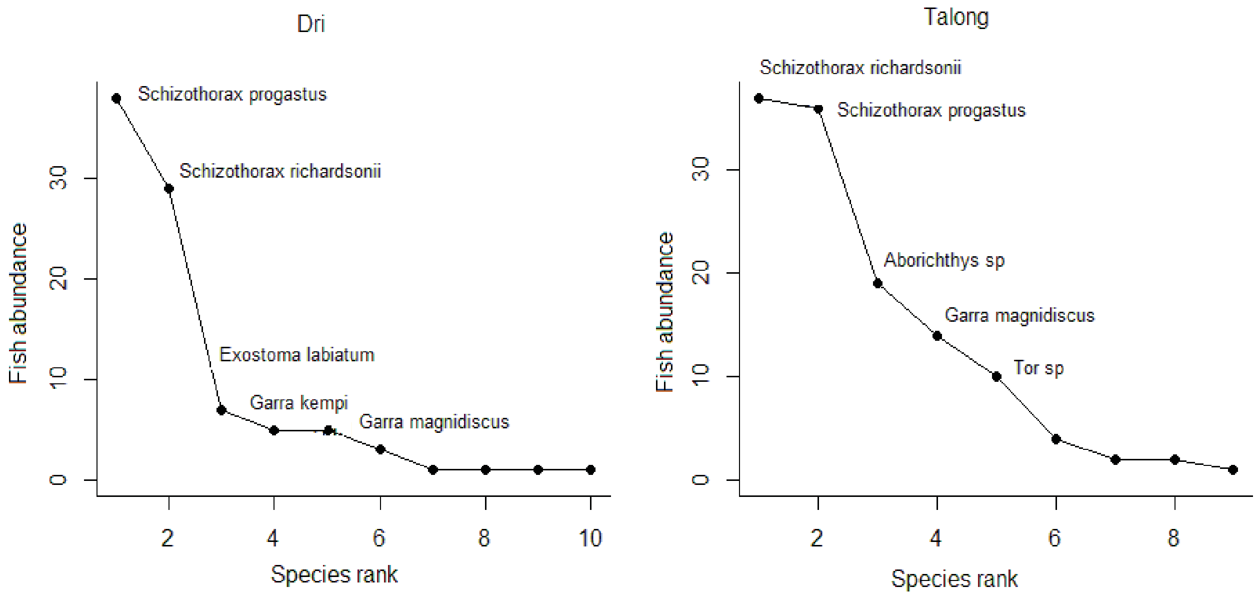


Figure 5.4: Rank abundance plot showing five dominant species in a) Dri and b) Tangon sub-basin

Table 5.50: Detailed information on fish species recorded within the study area (Dri basin, Tangon basin and below the confluence), their IUCN status and endemism (with reference to North-Eastern biodiversity hotspot in India.

Order/Family	Dri basin (count)		Tangon basin (count)		Abundance	IUCN	Endemic
	Upstream	Down	Upstream	Down			
Cypriniformes/Cyprinidae							
Garra kempi	5	0	0	4	9	LC	N
Garra magnidiscus	5	0	0	14	19	NE	Y
Schizothorax progastus	34	4	12	24	74	LC	N
Schizothorax richardsonii	29	0	4	33	66	VU	N
Tor sp	1	0	0	10	11	-	N
Cypriniformes/Nemacheilidae							
Aborichthys sp*	0	1	0	19	20	-	Y
Schistura sp*	0	0	0	2	2	-	Y
Cypriniformes/Psilorhynchidae							

Order/Family	Dri basin (count)		Tangon basin (count)		Abundance	IUCN	Endemic
	Upstream	Down	Upstream	Down			
Psilorhychus arunachalensis	0	0	0	2	2	DD	Y
Siluriformes/Sisoridae							
Creteuchiloglanis arunachalensis	0	1	0	0	1	LC	Y
Exostoma labiatum	0	7	0	1	8	LC	Y
Parachiloglanis bhutanensis	3	0	0	0	3	NE	N
Pseudecheneis sulcata	1	0	0	0	1	LC	Y

Overall, the fish richness was accumulated over 35 segments (**Figure 5.5a**). However, for each basin, the species accumulation steadily flattened and suggesting availability of few more cryptic species in the study area, that remain uncaptured during the study period (**Figure 5.5b**).

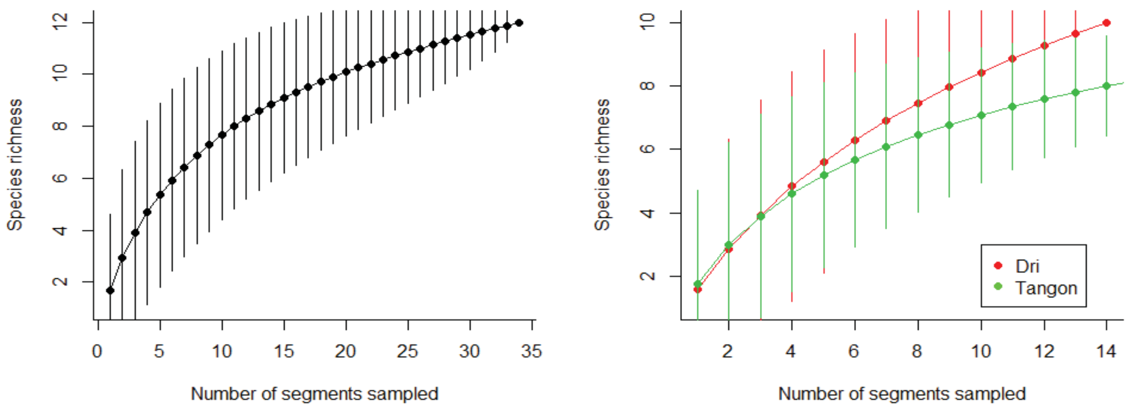


Figure 5.5 a: Species accumulation for Dri & Tangon basins combined b) Species accumulation for Dri and Tangon basins separately

a) *Fish composition*

Non-metric multi-dimensional scaling (NMDS) results show that Dri and Tangon basins have similar fish community composition (**Figure 5.6**), differing by only two species. *Creteuchiloglanis arunachalensis* and *Parachiloglanis bhutanensis* were recorded only in the Dri basin, while *Psilorhychus arunachalensis* and *Schistura* sp were recorded only in the Tangon basin. Seven species namely, *Garra kempi*, *G. magnidiscus*, *Schizothorax progastus*, *S. richardsonii*, *Exostoma labiatum*, *Aboricthys* sp and *Tor* sp. were common in both the basins.

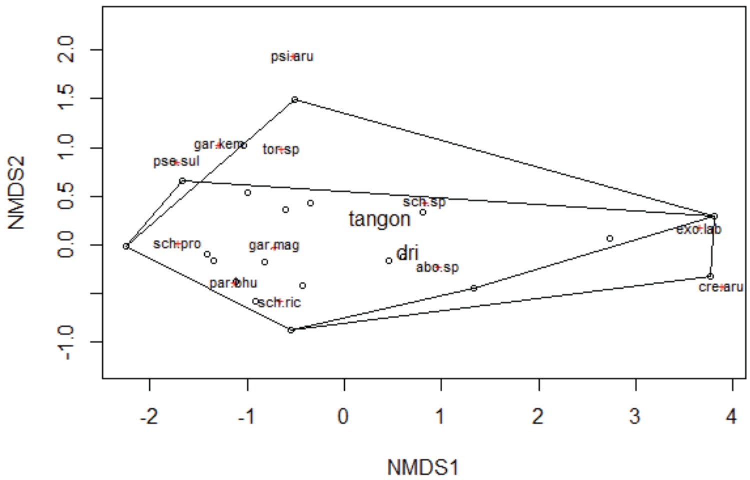


Figure 5.6: NMDS plot showing similar fish community composition in both Dri and Tangon sub-basins

b) Species diversity and habitat characteristics

Among the major river habitats sampled, pool habitat showed highest species richness followed by riffle, run and cascade habitats. Maximum number of species were captured during the pre-monsoon season and the least during the winter season (**Figures 5.7 a. & b**).

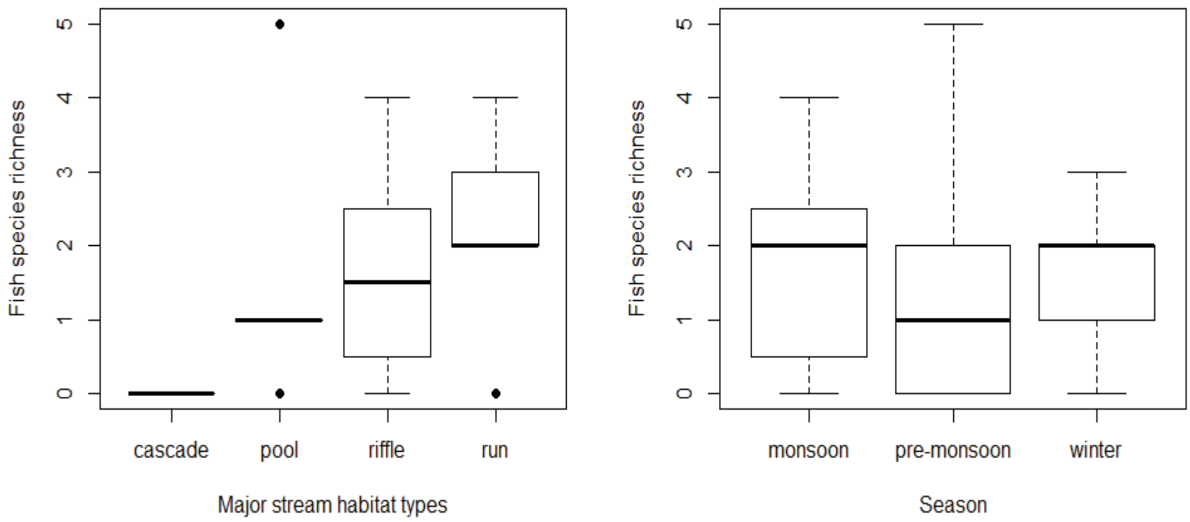


Figure 5.7: a). Fish species richness across different habitat types shows, pool was most species rich than riffle, run and cascade in the study area b). Fish richness show highest during pre-monsoon (mid-Feb to mid-March) than monsoon (mid-May to June) and winter (Jan-mid Feb).

Fish species richness and abundance declined with the increasing distance from the proposed dam site in Dri basin (**Figure 5.8 a & b**), while it was highest mid-way from the proposed dam in the Tangon basin (**Figure 5.9 a & b**).

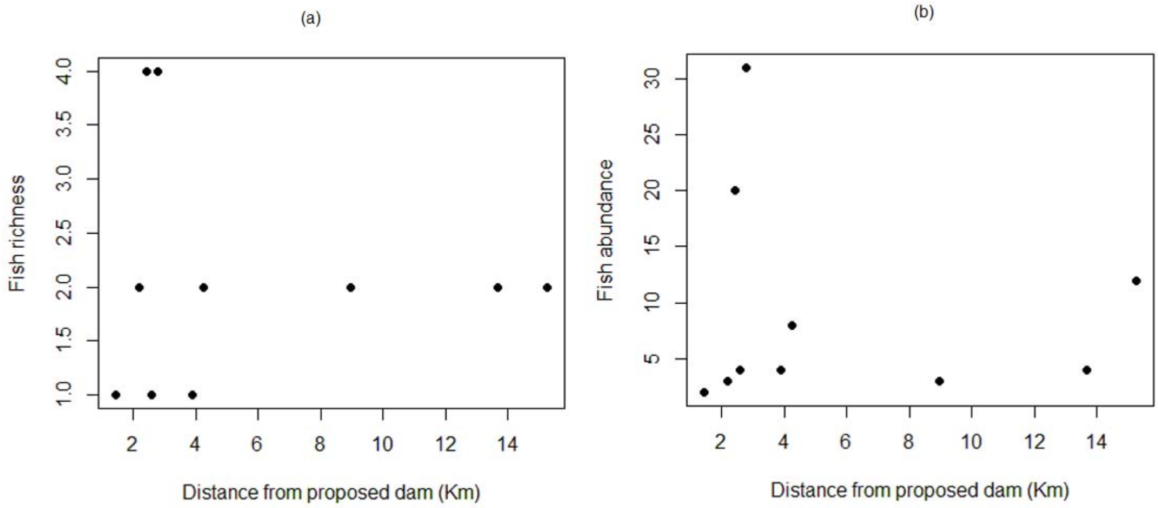


Figure 5.8: a) Fish richness and b) abundance declined with the increasing distance from the proposed dam in Dri sub-basin

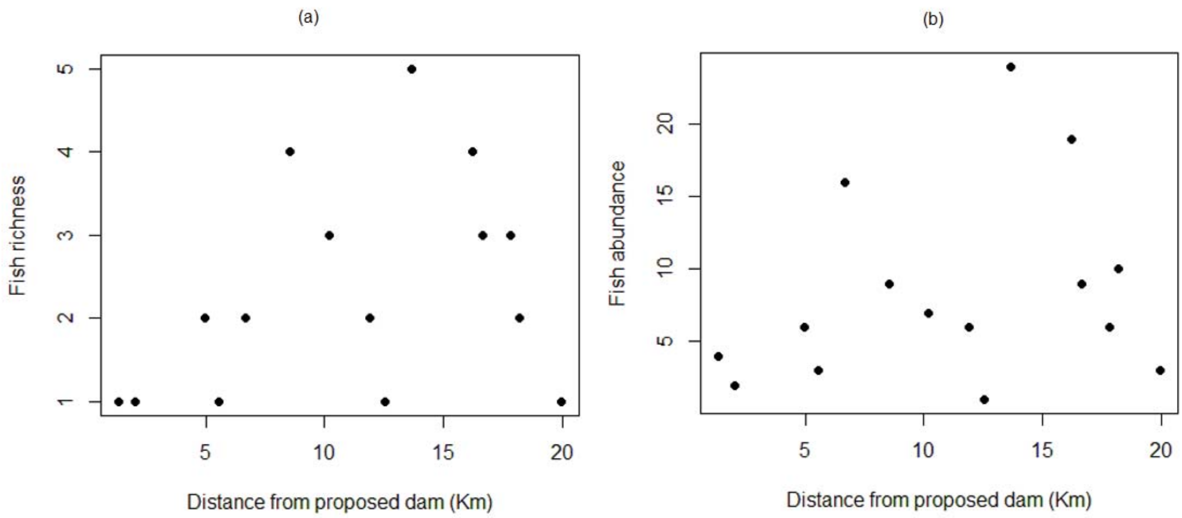


Figure 5.9: a) Fish richness and b) abundance was higher in the middle river segments in Tangon sub-basin

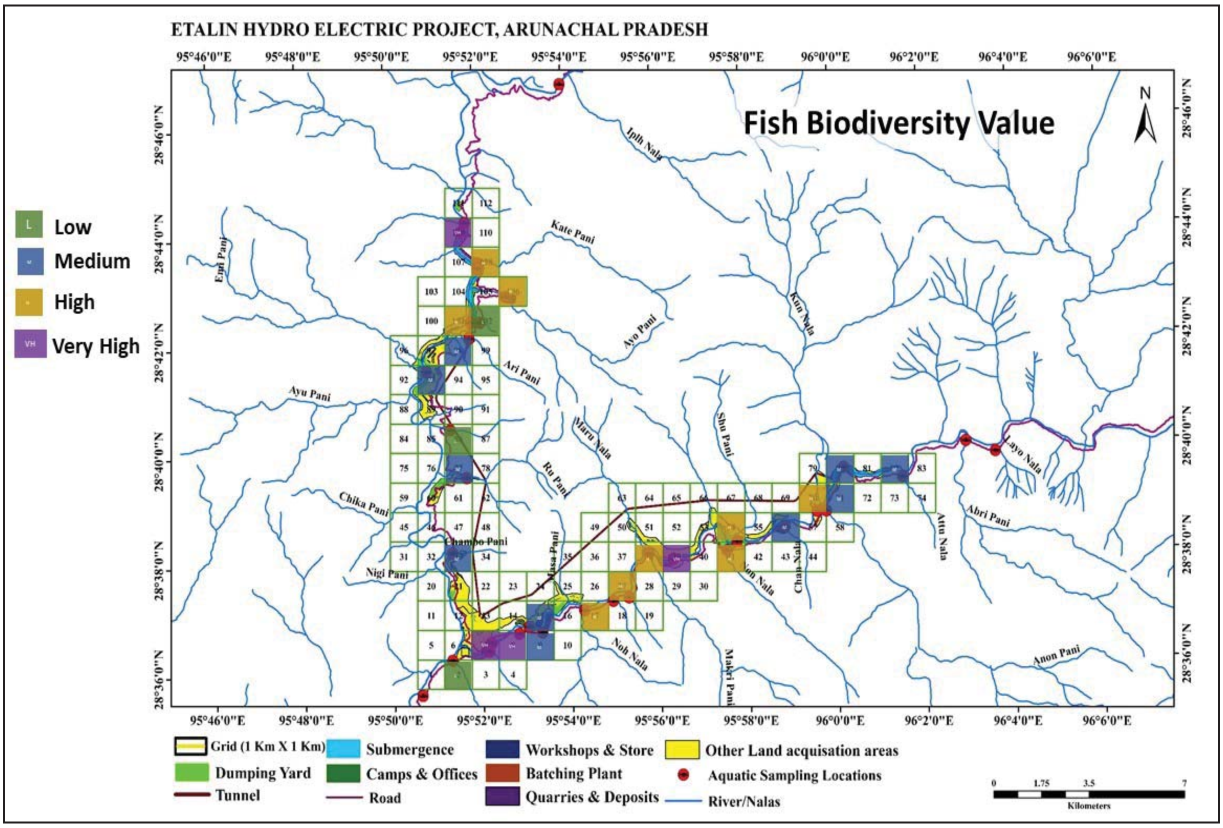
c) Species of conservation significance

Out of the 12 fish species recorded during the study, 30.6% are Vulnerable, while the rest are either Least Concern (43.1%), Not Evaluated (10.2%), Data Deficient (6%) or the status is not available (15.3%). In terms of endemism, most of the species are not endemic (79.6%), while 20.4% are endemic species. Of the total, 56.7% were captured below the proposed dam site, while 43.5% were captured upstream.

Although certain species might not have global significance with reference to their threatened status by not being of conservation significance (RET/endemic), but they might have high regional importance. For example, *Schizothorax* and *Tor* sp migrate within free-flowing stretches of Himalayan rivers, but the amount of distance covered by them is still unknown. In the present study, three species exhibited long-distance migration (within river) while, nine were short distance migrants, either restricted to special habitats such as headwater or undammed/undisturbed tributaries (**Annexure 5.11**).

5.3.2.3 Aquatic biodiversity values in EHEP

The aquatic biodiversity value was assessed on the basis of species richness, richness of RET species, migratory species, endemic species and the presence of breeding/congregation sites (**Map 5.10**). Along the Dri river, grids with very high and high biodiversity values (15% of total number of sampled grids) were restricted to the upstream sections, close to the proposed dam and submergence area. As compared to the Dri river, Tangon river has a greater number of grids with very high and high biodiversity values (34% of total no. of sampled grids), which are present throughout the river, downstream of the proposed dam location. In all these grids with very high and high biodiversity values, the RET fish species *Schizothorax richardsonii* was present and most of these grids had fish breeding sites and >60% of migratory species found in the study area.



Map 5.10: Grid-based Aquatic Biodiversity values within the Study Area

Plate 5.7: Some of the Fish Species recorded from the Etalin HEP study area

	
Schizothorax richardsonii	***Exostoma labiatum***
	
Schizothorax progastus	***Aborichthys sp***
	
Aborichthys sp	***Creteuchiloglanis arunachalensis***

	
Pseudecheneis sulcata	***Psilorhynchus arunachalensis***
	
Garra magnidiscus	***Tor sp***
	
Parachiloglanis bhutanensis	***Psilorhynchus arunachalensis***

5.4 Socio-culture Status and Biodiversity Conservation

5.4.1 Household and demographic profile of the Project Affected Villages (PAV)

Demographically, the total population of Dibang valley district is 8004 people (National Census, Govt. of India, 2011), of which 4414 are males and 3590 are females. About 70 % of the District's population is rural and rest 30 % is urban, restricted mainly to Anini, the district headquarters. Idu Mishmi is the lone tribe inhabiting the Dibang Valley district (**Table 5.51**).

For this study, 179 households in 22 villages out of the 294 PAFs identified for Social Impact Assessment and R & R Plan of EHEP Project, January, 2015 were surveyed. Kaduli and Matuli villages were surveyed as residents of Ayeso and Apayee villages, who have settled there for approximately last 20 to 30 years respectively. Imuli village was also surveyed on Dri side as residents of Ayeso village, who were also settled there (**Annexure 5.12 a & b**). About 20 villages, 178 families and 839 people are likely to be affected due to the proposed hydropower project. Total 23 villages were surveyed under this study. The number of persons interviewed were almost equally distributed between male (48 %) and female (52%) (**Table 5.51)**.

Table 5.51. Demographic Profile of the Villages Surveyed within Etalin HEP Study Area

S.No.	Circle / Village	No. of PAFs	No. of PAPs	Male	Female
Anini Circle/Dri basin					
1	Punli	17	88	38	50
2	Ayeso	1	1	1	0
3	Akobe	8	47	24	23
4	Yuron	3	6	2	4
5	Apayee	0	0	0	0
6	Aguli	5	24	12	11
7	Matuli	8	32	17	15
8	Kaduli	8	37	22	15
9	Imuli	2	11	6	5
Etalin Circle / Tangon basin					
1	Etalin HQ	34	157	73	84
2	Etalin Bridge Point	34	179	81	98
3	New Aropo	12	57	28	29
4	Emuli	0	0	0	0
5	Punli	3	15	9	6
6	Aruli	12	33	19	14
7	Athunli	11	63	32	31
8	Edili	1	1	1	0
9	Aunli	6	25	8	17
10	Apunli	0	0	0	0
11	Aliwu	1	1	1	0
12	Atyi	4	28	13	15
13	Azuli	2	8	3	5
14	Amuchi	4	14	6	8
15	Maayi	3	12	7	5
Total		**179**	**839**	**403**	**436**

PAF- Project Affected Families, PAP- Project Affected People; Source: Field Survey

5.4.2 Nature-based livelihood

Forest-based income: The Idu Mishmi community is largely dependent on the forest-based plant and animal resources for their livelihood and daily needs, such as collecting wild edible plant resources and wood for infrastructure development (**Figure.5.10**). The major source of dietary proteins is meat via traditional hunting. Livelihood is essentially nature-based – jhum agriculture, cane collection and collection of bamboo and other wood materials for the construction of household structures. Food gathering is a supplementary source of livelihood for the people. Non-Timber Forest Produce (NTFP) such as vegetables, fruits, barks, seeds, edible plants and leaves, are mainly derived from the forest. Some of the forest products (e.g., bamboo, broom grass, fodder species etc.) are collected throughout the year, while some are collected within specific time periods such as six months (e.g., Cane, bamboo shoot, *Paris polyphylla*, edible mushrooms etc.). Edible items from the forest are collected to fulfil food requirements. Collection of leafy vegetables, mushrooms, fruits and other edible items and fodder for livestock mainly pigs are primarily done by the women of the community.

About 38.2% of PAFs are dependent on forests and their resources, as being their primary source of income, which basically comprises of carpets, handicrafts made from bamboo, cane collection, timber, medicinal plant collection, and *Paris pollyphylla* collection.

Agriculture: Though, only 4% of the people are dependent on agriculture for their livelihood income, *jhum* agriculture or shifting cultivation is known for causing loss of forest cover and associated biodiversity values. Agriculture crops within the study area mainly include rice (keh), millet (yamba), buckwheat (eke), maize (ambo) along with a variety of vegetables such as pumpkin, chillies. With cardamom and orange as two major cash crops.

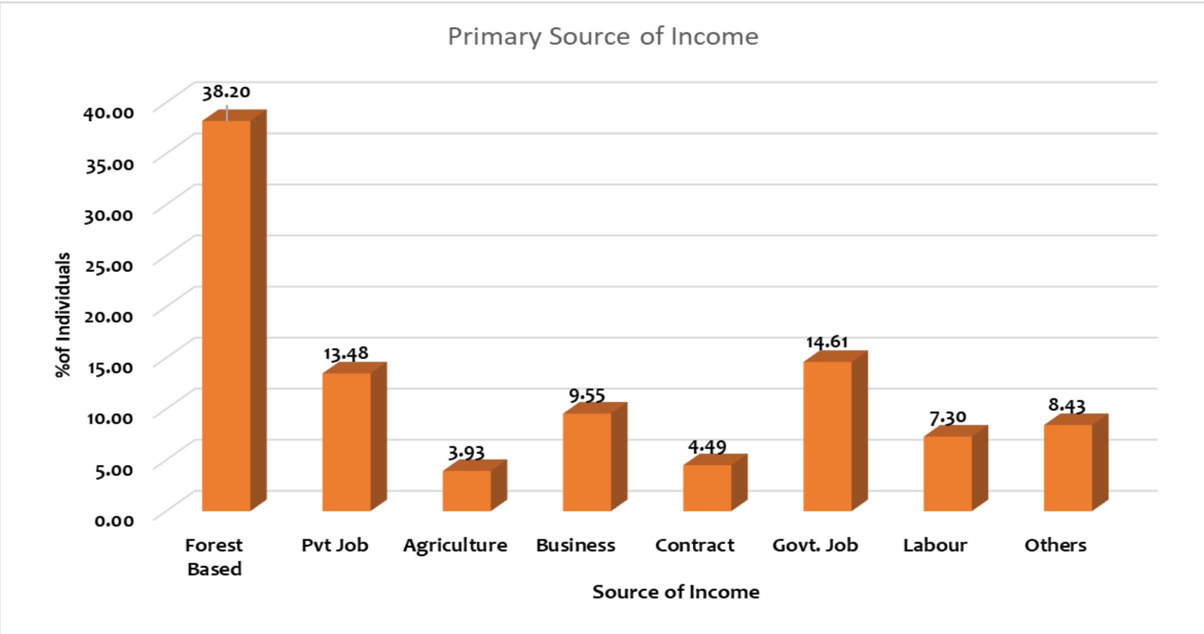


Figure 5.10: Primary sources of income of the project study villages

Cumulatively, direct forest-based income, agriculture and other nature-based incomes (8.43% handicraft, shamanism, and traditional handloom) contribute to 50% of the local livelihood, directly or indirectly (**Plate 5.8**).

Plate 5.8: Handicrafts made using Forest Products and Traditional Handloom

Traditional Handloom

Making Bamboo Plate

Making Bamboo Carpet

Different livelihood activities are either annual or seasonal (**Table 5.52**). Agricultural activities last for nearly one full year, leaving one-month gap in three phases (Jhum, burning, sowing and harvesting). Hunting takes place for six months in two phases (January-March and July – September). Collection of wild edible mushrooms, bamboo shoot and *Paris Polyphylla* are seasonal.

Table 5.52: Calendar of activities that people engaged in a year

Activities	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Laying Traps												
Takin Hunting												
Musk Deer Hunting												
Fishing												
Clearing Jhum												
Burning												
Sowing												
Harvesting												
Paris Polyphylla extraction												
Cane Collection												
Wild Edible Mushrooms												
Bamboo Shoot Collection												

5.4.3 Socio-cultural Importance of Natural Resources

5.4.3.1 Importance of Plant Resources

As discussed earlier, *Idu Mishmis* are traditional food gatherers, who collect wild edible plants, livestock fodder and medicinal plants from the forest and its fringe areas near the roadside (**Tables 5.53, 5.54, 5.55**).

The *Idus* are skilful in making different kinds of mats, caps, baskets, utensils with bamboo and cane for domestic and commercial use (**Table 5.53 & Figure 5.11**). The climatic condition and edaphic conditions of the study area facilitate luxuriant growth of different species of bamboo, cane and reed, which provide raw materials for the house construction as well as other essential articles of daily use e.g., baskets, mats, etc. Apart from bamboo, cane and reed, houses are also made with thatch / hay, palm leaves, and wood. Wood is used in the form of posts for which tall, straight trees are cut and debarked. The floor of the house is made of split bamboos (*Awruto, Abrato*), which is raised from the ground on wooden posts, three to five feet in length. The roof is of either thatched dry *ako* (*Livistona jenkinsiana*) or tin sheets. A fire place *(aengokho)* situated at the centre of every room serves for cooking and when cold the occupants sleep close to it. Over the fire hearth hangs a square-shaped bamboo shelf used to dry meat and fish.

Plate 5.9: Non - Timber Forest Produce Collection

Fuelwood Collection

Fodder Collection

Cane Collection

	
Broom Grass Collection	**Wild Edible Plants and Mushrooms: A much preferred Meal**

About 86.3 % of PAFs collect NTFPs, such as bamboo, cane, bamboo shoot, wild edible plants, fodder, fuel wood, broom grass, and grass for thatched roof, to meet their daily requirements. About 35.7 % PAFs collect timber, mainly for constructing houses (**Plate 5.5**).

Extraction of Paris polyphylla. Intensive collection of *Paris polyphylla* is a very recent trend among the local villagers. This wild tuber or rhizome is collected annually in enormous quantities as a quick and a good source of income. Though this natural resource is very rewarding the locals are unaware of its utilization and medicinal properties; some even felt that this rhizome is prone to overexploitation. They emphasized that regularisation of its extraction e.g., collecting it once in two years, was essential for its sustainable use (see **Box 5.1**).

Box 5.1. Extraction of *Paris polyphylla. "A quick and a rewarding income source"*

Paris polyphylla is a rhizomatous herb, which is extracted from the upper reaches of alpine meadows. Small groups of 5-10 villagers in few villages, mainly youths are involved in collection of *Paris polyphylla* annually from the forest areas of higher altitude. Sometimes, they have to travel till the international border (China) in search of this costly resource taking high risks. Generally, *Paris polyphylla* collection is planned for 20-30 days and they get into the remote forest areas to collect this rare plant produce. They have to take hardship and spend many days in very harsh climate with limited food (one meal / day) to collect the rhizome and process it (smoke dry) in the forest itself and bring back to sell it to the middleman either in Etalin or Roing. Since this rhizome fetches Rs 7000 to 8000/- per Kg, it is a good and quick income sources for the local villagers. This activity is supplemented with aid from state and federal agencies and occasional small-scale contractual work with the local government. Collection of *Paris polyphylla* is a recent development in Dibang Valley and in the last 5 - 6 years they involve in intensive collection between March to July and become one of the main activities. It appears now in their calendar activities from march to July. Due to rampant and reckless extraction of the species, it is facing tremendous pressure due to high market demand. Interaction with the youths revealed that, they understand that, *Paris polyphylla* collection is increasing annually and over exploitation is likely to reduce the productive potential of this rare plant resources and seeking way for sustainable use. Although it is an off-farm income resource or livelihood of the local community, they are not aware of its important medicinal properties, for which it is collected. Local people reported that although the rhizome of the species has high market value, they are not aware about the importance and use of the species.

***Paris polyphylla* tuber (Smoke dried)**

Paris polyphylla

Table 5.53: List of Edible and Fodder plant collected from Forest

S.No.	Idu (local) name	Scientific name	Part Used	Remark
1.	Alombo	*Phoenix sylvestris*	Pith	used as fodder
2.	Kuchu	*Colocasia*	Tuber	Edible
3.	Elokana	*Dioscorea dumentorum*	Tuber	Edible
4.	Etona	*Fagopyrum sp*	Leaf	Fodder & Edible
5.	Ahona	*Piper sp*	Leaf	Edible
6.	Athumbo	*Begonia sp*	Stem	Edible
7.	Amuli	*Houttuynia cordata*	Leaf	Edible
8.	Awrukana	*Elatostemma*	Leaf	Edible
9.	Alikona	*Piper sp*	Leaf	Edible
10.	Pra-ahkuna	*Chassalia*	Leaf	Fodder
11.	Ayaona	*Streptolirion*	Leaf	Edible
12.	Ambrachu	*Bamboo sp*	Shoot	Edible
13.	Maneimbo	*Colocasia*	Leaf	Fodder
14.	Setaka	*Solanum*	Fruit	Edible
15.	Lychee	*Nephelium*	Fruit	Edible
16.	Andhichu / Anjimbo	*Diplazium esculentum*	Leaf	Edible
17.	Aruna	*Carex sp*	Leaf	Fodder
18.	Aitina	*Impatiens sp*	Leaf	Fodder
19.	Ayitimbo	*Alpina sp*	Fruit	Edible
20.	Alopenga	*Mesa sp*	Fruit	Edible
21.	Tipurna	*Clerodendrum colebrookianum*	Leaf	Edible
22.	Bishi	*Ficus semicordata*	Fruit	Edible
23.	Enushi	*Rubus sp*	Fruit	Edible
24.	Myshana	*Spillanthes*	Leaf	Edible

Table 5.54: List of Medicinal Plants collected from Forest

S.No.	Idu (local) Name	Scientific Name	Part Used	Remark
1.	Tipurna	*Clerodendrum colebrookianum*	Leaf	High Pressure
2.	Aro	*Coptis teeta*	Root	Stomach-ache, Dysentry
3.	Wild Setaka	*Solanum myricanthum*	Fruit	Toothache
4.	Areba	*Ageratum conyzoides*	Leaf	Wound & Cut
5.	Athumbro	*Begonia josephii*	Leaf	Bone pain and selling, Cough
6.	Bithi	*Ficus semicordata*	Aerial root	Wound & Cuts
7.	Achamari	*Pouzolzia*	Leaf	Leech bite
8.	Arasapana	*Plantago sp*	Leaf	Wound
9.	Ilumuna	*Artemisia sp*	Leaf	Wound, nose bleed

Table 5.55: Details on Major Natural Resources dependency of Villagers of the Etalin HEP Study Area

S.No.	Circle / Village	Number of Families				
		PAFs	NTFP collection	Fishing	Timber	Hunting
Anini Circle/Dri basin						
1	Punli	17	16	3	7	9
2	Ayeso	1	1	0	0	0
3	Akobe	8	8	4	4	5
4	Yuron	3	1	1	0	0
5	Apayee	0	0	0	0	0
6	Aguli	5	5	2	5	4
7	Matuli	8	7	4	3	4
8	Kaduli	8	8	3	2	3
9	Imuli	2	2	2	2	2
Etalin Circle/Tangon basin						
1	Etalin HQ	34	20	7	9	6
2	Etalin Bridge Point	34	31	19	11	11
3	New Aropo	12	12	1	6	5
4	Emuli	0	0	0	0	0
5	Punli	3	3	2	2	2
6	Aruli	12	9	7	3	6
7	Athunli	11	11	6	4	6
8	Edili	1	1	0	0	0
9	Aunli	6	6	1	1	1

S.No.	Circle / Village	Number of Families				
		PAFs	NTFP collection	Fishing	Timber	Hunting
10	Apunli	0	0	0	0	0
11	Aliwu	1	1	0	0	0
12	Atyi	4	4	2	3	2
13	Azuli	2	2	0	1	1
14	Amuchi	4	3	4	1	3
15	Maayi	3	3	0	0	0
	Total	**179**	**154**	**68**	**64**	**70**

PAF - Project Affect Family; NTFP – Non-Timber Forest Produce; Source: Field Survey

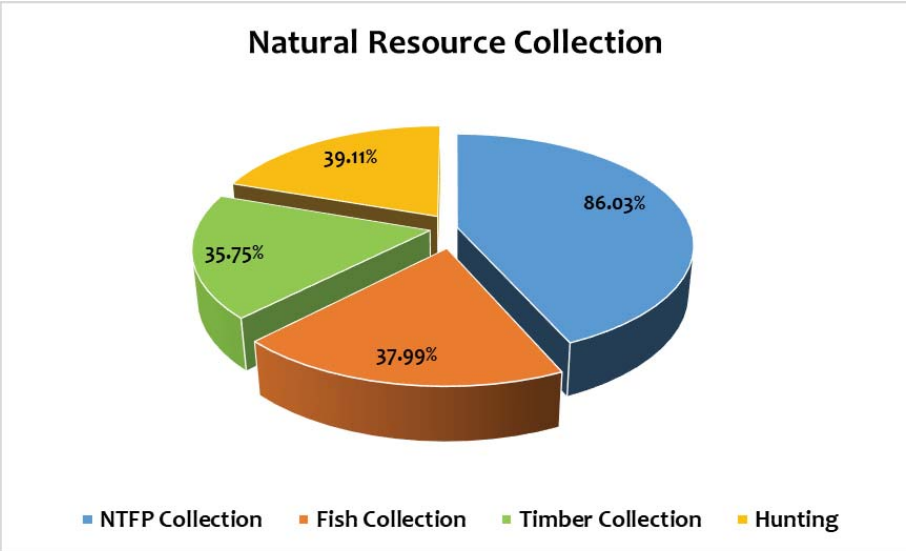


Figure 5.11: Natural Resource Collection

5.4.3.2 Importance of Animal Resources

Wild meat is the major source of protein for the locals and 39% of the local population is engaged in hunting. While hunting is done mainly for meat consumption, occasionally the meat is sold for commercial purposes, particularly that of musk deer (*Ala*). In addition to hunting, 39% of the people are dependent on fishing for supplementing their protein requirements. Natural resources also play vital role in fishing activities of the people e.g., a variety of fishing trap called *tha* is made of bamboo.

Hunting

i. Animals

Although hunting is an integral part of the community's tradition, it is in general, one of the major threats to wildlife in Arunachal Pradesh. Animals are primarily hunted for meat, but at the same time there is a local demand for skin, teeth, feather, beaks and other animal parts, for making traditional dresses and medicines. Wildlife is also hunted as a result of livestock/human-wildlife conflict (**Annexure 5.13**). During the survey, several indirect animal evidences as a result of hunting were found in local houses such as skin, horns, antlers, hairs and skulls of different animal species (**Plate 5.6**). This information along with data generated from local interviews was used to supplement the fauna checklist (mammals and birds) of the study **(Figure 5.12).** A total of 30 mammals were reported by ethnic hunters. According to the hunters, barking deer and wild boar were the most frequently hunted species followed by goral, takin, Asiatic black bear, serow, and musk deer. Both guns and locally made traps are commonly used for hunting. Hunting is mainly carried out in winter season (**Table 5.52**) but musk deer is targeted mainly during August to September. People prefer wild meat but tend to consume domestic meat more often.

Plate 5.10: Some of the Trophies and Skins of Wildlife Displayed in the Local Villagers House

Bag made out of Bear skin: used by local people

Igu (Priest) donning belt made from Tiger teeth

Display of Takin skull

Display of Wild pig Jaw

Figure 5.12 – Distance travelled by hunters for hunting wild animals

ii. Birds

Apart from hunting birds for flesh, bird has special aesthetic and cultural importance in the *Idu Mishmi* community. The species of this taxa are also hunted for beaks for wall decoration, to test/train hunting skills as well as for recreation/sport. Flesh of species such as wild fowls, hornbills, pheasants, bulbul, pigeon, myna, dove are widely consumed. Species like vulture, crow and owl are restricted for consumption. Interviews with locals revealed that they hunt approximately 42 species of birds (**Annexure 5.14**), including three species listed as threatened species (IUCN Red List) and six species are Schedule I species.

iii. Hunting of RET species

Although hunting is a traditional right of *Idu Mishmis*, hunting of bird and mammal species of conservation significance i.e. RET and endemic species, is a matter of concern (**Annexure 5.13 & 5.14**). Among the 30 species of mammals, few mammal species, such as Wild Dog, Yellow-throated Marten, Wild Pig, Leopard Cat, Macaque are hunted due to conflict issues such as cattle and poultry lifting and crop riding. Other protected species such as Asiatic Himalayan Black Bear and Alpine Musk Deer are hunted for commercial purposes. Though the *Idu Mishmi* community does not hunt the tiger as it is considered as next to human kin, preference for higher altitudes by this species also reduces their hunting threat. It is essential that the awareness regarding protection and conservation of RET species is made among local people.

iv. Transboundary Hunting

Transboundary hunting is another major threat. According to the local hunters, Chinese hunters regularly come into the Indian territory in groups of four equipped with sophisticated hunting weapons and hunt.

v. Customary Restriction

Idu Mishmi observe customary restriction (*Aena*) for five days when they hunt. *Aena* can function as effective conservation tactic. Large animal killings, demand various personal sacrifices and restrictions, usually for at least five days. The hunter has to observe celibacy for five days, where one cannot bath, eat garlic/ginger/mushroom/salt, or wash clothes. Even if one eats any wild meat (from jungle), during Aena, there is a penance. *Aena* is particularly strict with respect to tigers, the apex predator in the region. Tigers can only be killed in self-defence, or if it is a man-eater. If a tiger is killed otherwise, the entire village has to observe *Aena*, making tiger protection a collective responsibility. *Aena* ensures that the *Idu Mishmi* continue to respect the ecosystem they inhabit.

5.4.3.3 Religious importance of Natural Resources

Nature and forests play an important role in the religious practices of the *Idu Mishmi* people. *Idu Mishmi* follow animism i.e., attribution of living soul to plants, inanimate objects and natural phenomenon. Spirits or *khinyu* are said to be abound in jungles, hills, shadowy recesses, rivers, gorges, cliffs and are feared by the *Idu*s (Bhattacharjee,1983). Their supreme God *Inni*, embodies the highest ethical conception (Baruah, T.K., 1960). Traditionally, an *Igu* (Shaman) is a key figure of religious beliefs and practices in the *Idu* society (Chaudhary, S.K., 2008), who utilizes many natural resources to carry out his rituals (**Table 5.56**).

Table 5.56: Types of natural resources used for religious and cultural belief

Local Name	Scientific Name	Use
Abrato	*Bambusa pallida*	Used as *Tothro* during funeral ceremony (*Yaa*) to ward off evil spirit and protect *Igu* and family members of the departed Considered as a sign of fertility; newlywed bride carries it to husband's house Used in traditional handloom
Kalita	Wild Turmeric	Used as medicine by Igu
Eluna	*Caryota* sp.	*Ayuta* (leaf broom) used by Igu during funeral ceremony
Aekambo		Aekana (leaves) is used before going to jungle for hunting; ritual is called Abuthu
Aepho	*Saccharum* sp.	Used during childbirth and is kept permanently at home
Amralaa	*Panthera tigris*	Tiger teeth belt Adorned by Igu – reflects the braveness and strength and gets spiritual power from it
Ahulaa	*Ursus thibetanus*	Bear teeth belt Adorned by Igu – reflects the braveness and strength and gets spiritual power from it
Ripooh		Small drum whose body part is made with root of Mangtoh (bamboo sp), Skin part is made from skin of Monitor Lizard (Akupra), skin of goral (Amikopra)
Ahona	*Piper* sp.	Very important in all ceremonies viz. wedding, birth, funeral

5.4.3.4 People's Perception on Etalin HEP Project

The social survey also included component/ aspects related for understanding the people's perception on the proposed EHEP project. Interaction with the locals showed that, as per people's perception 69.3 % of PAFs are in favour of the Proposed EHEP Project. They discussed many reasons for the support of the project, which mainly includes, making use of the potential of hydropower, better education, health, infrastructure facilities, job and enhancement of life quality (**Table 5.57**). Only 5 % of the PAFs were not favourable for the proposed project due to various reasons and the main reasons being loss of land and threat to their culture due to influx of outsiders. The remaining of slightly more than 20% of PAFs were neutral for the project i.e. neither in favour nor against the project (**Figure 5.13**).

An Environmental Public Hearing in respect of Etalin Hydro Electric Project (3097 MW) executed by M/s Etalin Hydro Electric Power Company Limited was conducted on 12.12.2014 from 10.00 AM onwards at Etalin HQ, Dibang Valley District, Arunachal Pradesh. The entire Public Hearing proceeding was presided over by Shri Tamune Miso, Deputy Commissioner, Anini, Dibang Valley District - cum - Chairman of the Public Hearing. In all 545 (five hundred fourty five) people attended the Public Hearing. The range of issues raised by PAFs/ public have been clarified by the developers in detail.

Table 5.57: People's Positive and Negative Perception on the proposed Etalin HEP Project

Positive Perception and Expected Benefits			
S.N.		**S.N.**	
1	Arunachal Pradesh has high potential of hydropower generation so Government should harness it for generation of electricity	**7**	Development of sports complex for encouraging youth in sports
2	Unremitting electrical supply at a subsidised rate	**8**	Generation of job opportunities in the project
3	Auxiliary business opportunities for locals	**9**	Living standard of locals will improve – life quality
4	Ancillary infrastructure development	**10**	Development of modern civic amenities
5	Economic up-liftment of local people	**11**	Growth in tourism, will serve as auxiliary source of income
6	Education and infrastructural development	**12**	Development of medical facilities
Negative Perception and Expected Conflicts			
1	Cultural Conflict in the form of intercultural mixing due to influx of outsiders	**4**	Women safety
2	Loss of grazing land for the Mithun and thereby loss of a traditional practice	**5**	Resettlement and loss of community land
3	Threat to culture and Idu dialect	**6**	Illegal settlement of outside labours
		7	Destruction of Natural Resources and largescale depletion of resources

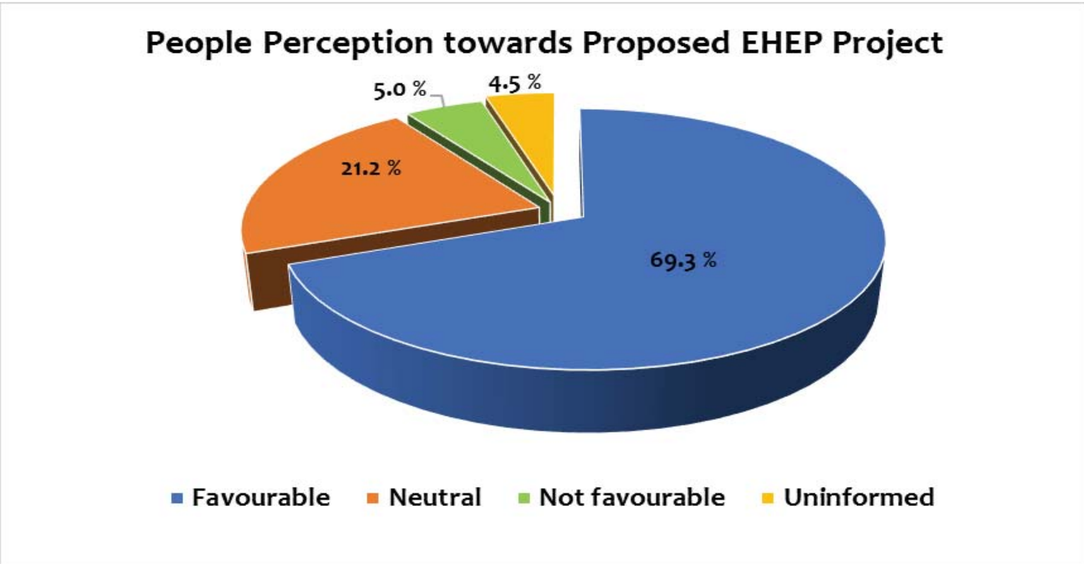


Figure 5.13: People Perception towards proposed Etalin HEP Project

CHAPTER 6: Assessment of Impacts of hydropower on key biodiversity areas & values

6.1. INTRODUCTION

All the development programs like infrastructure, urbanization, energy, mining, water, policies and other development projects can cause significant changes in many features of the physical, biological and social attributes of the project environment. In some cases, the changes may be beneficial while in other it may be detrimental. However, the occurrence and magnitude of these changes or impacts entirely depend on the type and nature of project, project location, and the technology involved in implementation (construction and operation) and management. Hence, environmental impacts studies must systematically identify qualify and appropriately interpret the significance of these anticipated changes or impacts.

The major environmental problems associated with the development programs are: deforestation, soil erosion, disturbance to hydrological regime, pollution (water, air and noise), and reduction of floral and faunal diversity, health and resource use (ED-World Bank 1998). These impacts ultimately lead to degradation of land which affects the overall biomass productivity and quality of human life in the vicinity of project areas. Development projects in any given region must learn to respect the ecological integrity and biodiversity values of the region as these are going to be the determinants of environment quality as well as the sustainability of the development interventions. With determination and effort these unwanted consequences of development can be reduced substantially, as we progressively hone our technical and managerial skills for preventing and/or mitigating them. This clearly vouches for a well-planned Environmental Impact Assessment.

Therefore, it has been emphasized that, thorough understanding of biological attributes covering species diversity, community structure and site-specific soil-plant-animal relationships of a given geographical region, not only aid for assessing the impacts, but in help in mitigating the changes and restoration plans (Wali and Freeman 1973., Fisser and Ries 1975 and Soni *et al* 1992).

6.2. IDENTIFICATION OF POTENTIAL SIGNIFICANCE OF TERRESTRIAL BIODIVERSITY – SPATIAL SCALE

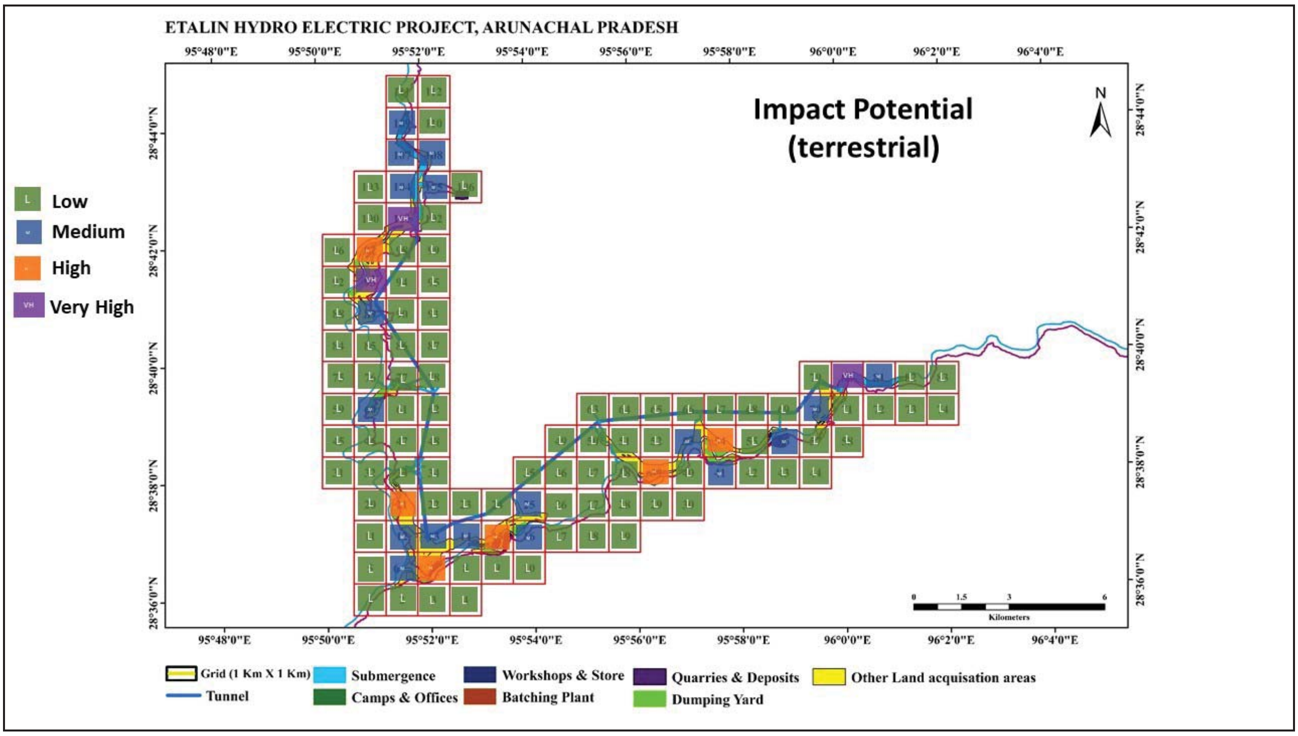
The impact identification and evaluation were done at two levels based on the biodiversity values of terrestrial habitat:

- **Impact potential of the EHEP – Spatial Scale**
- **Significance of the impacts of EHEP – Spatial Scale**

The above two applications show the impact potential and significance of impact of EHEP at spatial scale within the project area along the two river basins and the outcomes of which are discussed below

6.2.1. Impact Potential of the EHEP with respect to Terrestrial Biodiversity –Spatial Scale

The impact potential of the EHEP within the zone of impact - ZoI (**Map 6.1**) using the criteria defined previously, as expected showed that grids containing the proposed dam, involving the largest areas of acquired land (equivalent to habitat loss), have very high to medium impact potential values. The downstream of the Dri limb showed predominately low potential with few high potential grids, while comparatively the Tangon downstream had more grids with high and medium impact potential (**Map 6.1**).

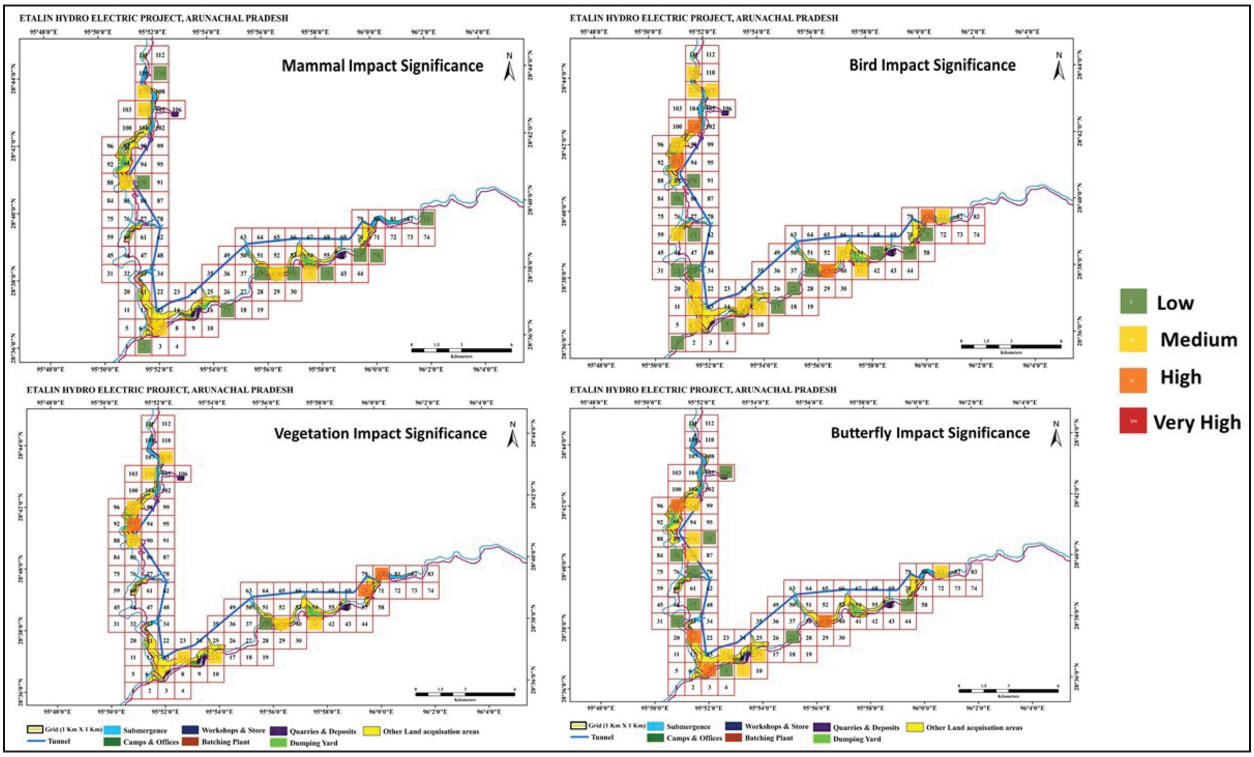


Map 6.1: Impacts Potential of EHEP w.r.t. Terrestrial Biodiversity

6.2.2. Significance of the Impacts of EHEP on Terrestrial Biodiversity – Spatial Scale

This exercise indicates relative ranking of impact significance on biodiversity in the two basins taking into consideration the biodiversity values and impact potential values of the sampled grids. It clearly outlines that different parts of the study area will be affected with varying levels of impacts if the current hydropower plan is implemented (**Maps 6.1 &6.2**).

The negative impacts of the proposed dam and forest loss due to submergence and other activities on mammals, will likely be of medium to low significance in both the basins. Of the assessed grids w.r.t birds and butterflies, approximately 55% have high to medium impact significance implying that the impacts of EHEP on these taxa will be of high/medium significance particularly close to the confluence and the proposed dam locations. For vegetation as well, the significance of negative impacts of the dam and associated forest loss will be medium to high.



Map 6.2: Significance of Impacts of EHEP on Terrestrial Biodiversity

6.3 IMPACTS OF PROJECT ACTIVITIES ON BIODIVERSITY – MICRO LEVEL EVALUATION

In general, impact prediction methods argue that the foremost step in impact appraisal must consider and identify project actions that are likely to bring significant changes in the project environment. The list of proposed project actions likely to impact up on different components of the project area is detailed in **Table 6.1.** Though, the project development activities can be divided into four major activities like; 1. Construction of civil structures, 2. Mechanical and Electrical design, 3. Power Evacuation and 4. Infrastructure development, only civil construction activities are found to significantly affect the physical, biological and social components of the project area. Since the other mechanical, electrical and power evacuation activities lie well within the major civil construction area, not much impacts are likely to occur.

6.3.1. Predicted Impact Matrix

The level of impacts was predicted, with the understanding of the nature and list of project activities, and their locations, and correlating the estimated biodiversity values of floral and faunal groups and socio-cultural attributes of the project villages. The nature and magnitude (positive or negative, direct or indirect, short term or long term, local or strategic, reversible or irreversible) of impacts were evaluated based on the quantitative assessment of floral and faunal component like, species richness, species diversity index and presence of RET species. The impacts of proposed project on social aspect were assessed based on the natural resource depletion due to project and its impacts on resource dependency of local villagers inhabiting the project area.

Project activity-based impact matrix prepared with the understanding of nature of each activity predicted to have impacts on physical, biological and social values of the project area (**Table 6.1**). Since any project activity is expected to affect more than one component and the impacts are interlinked among physical, biological and social attributes, the magnitude of impacts is discussed on the basis of project activities at micro level and their influence on different sub-components of biodiversity attributes: habitat, species group and specific species. The impact matrix prepared for some of the project activities are discussed below.

Conversion of land for the project implementation has been visualized as loss of habitat (terrestrial – forest, community land and aquatic – river and streams) and this will have direct impact on associated floral and faunal diversity. Loss of community land results in resource depletion.

Construction of all the mega structures like dam walls, power houses, tunnels and infrastructures, and associated earth work and excavation, material transportation. Are anticipated to impact all the terrestrial and aquatic components in the form of pollution followed by habitat degradation, which will indirectly lead to decrease in species richness and diversity of all the faunal groups.

Some of the supportive construction phase activities such as; muck dump handling, quarry activities, movements of heavy equipments, are visualized to affect specific faunal species like butterfly and avifauna due to severe dust oxides emission and habitat degradation, It is also predicted to have direct impact on herpetofauna and small mammals due to noise and vibration in the form of restriction of movements and population isolation.

Widening of existing roads and new road construction and intensive vehicle movement to transport all materials and work force are visualized to have direct impact on herpetofauna and small mammals in the form of road kills, but the magnitude will be minimal.

The positive impacts of infrastructure development like. additional roads, schools, health care facilities, skill development and job opportunities are expected to improve the life quality of local population.

On the other hand, migrant work force may influence on natural resources depletion, impact on faunal species, through indulging in illegal hunting and poaching and on local cultural values (**Table 6.1**).

The above predicted impacts are evaluated and discussed in detail, on the basis of specific project activities in the following sections.

Table 6.1. Impact Matrix based on list of proposed Project Activities and their possible Impact on Physical, Biological and Social components of the Etalin HEP Study Area

	Project activities/actions	Physical			Biological Aquatic		Biological Terrestrial		Social	
		Land-Soil Forest & Riverine Habitat	Air Dust/Gas	Noise/ Vibration	Water - River & Stream	Fauna	Flora	Fauna	Resource	Social& Culture
1	**Land Acquisition-conversion of Forest land/habitat project development**	X			X	X	X	X	X	
2	**Project Development Activities**									
2.1.	***Construction of all civil structures***									
	Dam, River diversion cannel, Intake, De-silting structure, Headrace tunnels, Surge Shaft, BVC-Pressure Shafts, Power House Complex. Dam-toe Powerhouses – **Land preparation Excavation**	X	X	X	X	X	X	X		
2.2.	**Mechanical and Electrical design**	-	-	-	-	-	-	-	-	-
2.3.	**Power Evacuation**	-	-	-	-	-	-	-	-	-
2.4.	**Infrastructure Facilities**									
	1.Project roads, 2. Bridges, 3. Project Colonies, 4. Job facility areas, 5. Quarry and Borrow areas, 5. Muck Disposal areas. 6. Explosive Magazine, 7. Land Requirement, 8. Construction power, 9. Telecommunication and other facilities, 10. Security and safety.	X			X	X	X	X	X	
	Supportive activities									
2.4.1	Muck-dump handling – excavation, Disposal -	X	X		X	X	X	X		

	Project activities/actions	Physical			Biological Aquatic		Biological Terrestrial		Social	
		Land-Soil Forest & Riverine Habitat	Air Dust/Gas	Noise/ Vibration	Water - River & Stream	Fauna	Flora	Fauna	Resource	Social& Culture
	Muck transportation and Dump development									
2.4.2	Quarry- Drilling, Blasting, and handling		X	X				X		
2.4.3	Project Roads - widening of existing roads and construction of new roads	X			X	X	X	X	X	X +
2.4.4	Movements of Heavy Vehicles and Operation of Machines		X	X			X	X	X	
2.4.5	Construction of New Bridges				X	X				X +
2.4.6	Workshops – hazardous waste disposal	X	X	X	X	X				X
3	**Influx of Labour force- Project construction**									
3.1	Construction of Labour colonies	X					X	X	X	
3.2	Dependency of Forest resources – NTFP, Bamboo and Wood resources	X					X		X	
3.3	Illegal activities – fishing, hunting and poaching							X	X	X
3.4	Indiscriminate solid waste disposal	X			X	X				
3.5	Influence on social and cultural values									X

6.4. LAND ACQUISITION – IMPACTS ON FOREST/COMMUNITY FOREST LANDS

One of first and foremost project activities is acquisition and conversion of land for the construction of power house and development of different project associated infrastructures. This proposed hydropower project involves conversion of the land area into different land uses, which include: Dam and Reservoirs, River diversion cannel, De-siltation structure, HRTs, Surge Shaft, BVC-pressure Shafts, Power house and Power house complex, and Dam-toe-power houses. In addition, part of the land will also be used for the development of other infrastructure facilities such as: additional roads, bridges, inbuilt power unit, office premise, residential colonies, labour camps, recreation centre, gardens, shopping complex, schools, play areas, hospitals, etc.

6.4.1. Acquisition of Forest and Community Forest Lands – Impacts of Habitat Loss and Biodiversity Values

The development of Etalin HEP project of Hydro Power Development Corporation of Arunachal Pradesh Limited (HPDCAPL) covers a total project area of **1155.11 ha** (Surface Land 1063.78 ha + Underground Area 91.33 ha) (**Table 6.2**). Therefore, conversion of both Unclassified State Forest (USF) and Community Forest Lands for the generation of 3097 MW Hydro Power and development of associated infrastructures are visualized to have the following direct / primary impacts:

Impact 1: Conversion of forest lands and followed by deforestation, earth works, soil erosion and land degradation are identified as loss of forest habitat- Direct and Primary Impact.

Impact 2: Loss of forest land would directly impact upon the floral community of the project area- Direct and Primary Impact

Impact 3: Decrease the biodiversity (species richness and abundance) status of major faunal groups inhabiting the forest habitat - Direct and Primary Impact.

Evaluation - Land Resources: For development of the project the land would be acquired for construction of project components, submergence area, muck dumping, quarrying, construction camps and colony, etc. According to the project land details, the proposed project required would be **1155.11 ha** (Surface Land 1063.78 ha + Underground Area 91.33 ha) (**Table 6.2**).

Table 6.2: Land Requirement Details of EHEP-Project
[For Legends (LA -1 to LA -21A) refer to figure 6.1 in page -176]

S.no	LA	Name of the Component	Area (Ha)
1		RQ1 (Rock Quarry)	
2		RQ2 (Rock Quarry)	
3		Contractor / Owner site office and store	58.02
4		Dumping Yard, DMD-4 (a)	
5	**LA-1**	Dumping Yard, DMD-4 (b)	
6		Labour Camp-5	

7		DT -RB(Diversion Tunnel- Right Bank); 3 Nos. (DRI LIMB)	
8		DT -LB(Diversion Tunnel- Left Bank); 1 No. (DRI LIMB)	
9		Dam/ Dam Toe Power House & Coffer Dam D/S	
10		Intake Structure	
11		Project Roads	
12		Explosive magazine/construction facility areas and labour camps (Right Bank)	
13	**LA -2**	Work Shop, Warehouse, Store &	56.53
14		Parking Space-3 (Left Bank)	
15		Dumping area DMD 5 (Left bank)	
16		Project Roads	
17		Dumping Yard, DMD-3	
18	**LA-3**	Dumping Yard, DMD-2	20.05
19		Total Road Area in LA -3	
20	**LA-4**	Labour camps	23.98
21		Total Road Area in LA -4	
22		Store/ work shop for package- B	
23	**LA-4A**	Batching plant / main work shop	67.74
24		Contractors camp and owners camp office/residences	
25		Provision for Priority Road (Dri Limb)	
26	**LA-5**	Road Area	2
27		Batching Plant/ work shop	
28	**LA-6**	Labour Camp-4	39.79
29		Dumping Yard, DMD-6	
30		Total Road Area in LA -6	
31	**LA-6A**	Provision of facility area/explosive magazine and change in road alignment	12.33
32		Batching Plant	
33		Dumping site	
34	**LA-7**	Aggregate crushing plant	80.56
35		Batching plant and aggregate stock piling	

36		Batching plant and work shop	
37		Total Road Area in LA -7	
38	**LA-7A**	Provision of change in portal & alignment of road	6.38
39	**LA-8**	Batching Plant BM-6	120.65
40		Batching Plant BM-7	
41		Contractor & Departmental Office-2	
42		PQ-01 (Shoal Quarry)	
43		Labour Camps	
44		Power House	
45		Main store/workshop and facility areas	
46		Total Road & Bridge (PPB1) Area in LA -8	
47	**LA-9**	Dumping yard EM & HM Storage Workshop, Warehouse, store, Parking	
48		Total Road & Bridge (PPB1) Area in LA -9	
49	**LA-10**	Owners temporary colony and office	11.31
50		Dumping Yard, PMD-2	
51		Total Road Area in LA -10	
52	**LA-10A**	Provision of Shoal Quarry PQ-02	9.77
53	**LA-11**	Road Area	41.38
54	**LA-11A**	Provision of Shoal Quarry PQ-03	17.2
55		Contractors colony and office and facility areas	
56	**LA-12**	Batching Plant and aggregate processing plant	52.79
57		Labour camps for Contractors Colony-EM, HM &	
58		Civil PH Works	
59		Penstock fabrication yard	
60		Dumping Yard, TMD-7 / PQ-02	
61		Total Road Area in LA -12	
62	**LA-13**	Site office and work shop	8.33
63		Total Road Area in LA -13	
64	**LA-13A**	Provision of facility Area	1.5

65	LA-14	Main Project Office and Residential Campus including school and hospital (Left Bank)	67.78
66		Road & Labour Camp	
67		Main work shop and batching plants	
68	LA-14A	Labour camps for contractor (Right Bank)	31.49
69		Road Area	
70	LA-14B	Additional Bridge to access Adit T2 & T3	6.99
71		Contractors colony	
72		Dumping Yard, TMD-5	
73		Dumping Yard, TMD-4	
74		Batching Plant BM-3	
75	LA-15	Labour Camp -2	79.18
76		Dumping Yard, TMD-6	
77		Dumping Yard, TMD-7	
78		Aggregate crushing plant	
79		Total Road Area in LA -15	
80	LA-15A	Access to Adit T3 and explosive magazine	14.3
81		Adit T-1 portal re-located (Right Bank)	
82	LA-16	Workshop and construction facility areas (Right Bank)	23.27
83		Total Road Area in LA -16	
84	LA-17	Shoal deposit	16.24
85		Additional In-situ rock quarry	
86		Stone Crucher TAPP-2	
87		Batching Plant BM-2	
88	LA-18	Contractor & Departmental Office Space-1	57.65
89		Store / workshop and construction facility areas	
90		Dam/ Dam Toe Power House & D/S Coffer Dam	
91		Total Road & Bridge (PTB1) Area in LA -18	
92		Batching plant	32.82
93		Dumping Yard, TMD-2 and batching plant	

94	**LA-19**	Workshop, Warehouse, Store & Parking Space-1	
95		Diversion Tunnel (Tangon) 3 Nos.	
96		DAM/ DAM Toe Power House	
97		Total Road Area in LA -19	
98		Dri Reservoir, U/S Coffer Dam	
99	**LA-20**	& Project Roads	83.32
100		PQ-04 (shoal quarry)	
101	**LA-20A**	Realignment of existing road to be submerged & provision of dumping yard u/s of dam	20.44
102	**LA-20B**	Provision of foot track along Dri reservoir	9.32
103		Additional land for road to Dam top	
104	**LA-20C**	Provision of priority road (Dri area)	6.16
105	**LA-21**	Tangon Reservoir, U/S Coffer Dam	36.12
106		& Project Roads	
107	**LA-21A**	Provision of foot track along Tangon reservoir	6.89
108	**EBP**	Project Colony & Office establishment	12.02
		Total	**1155.11**
		Surface Land **1063.78 ha +** Underground Area **91.33 ha**	

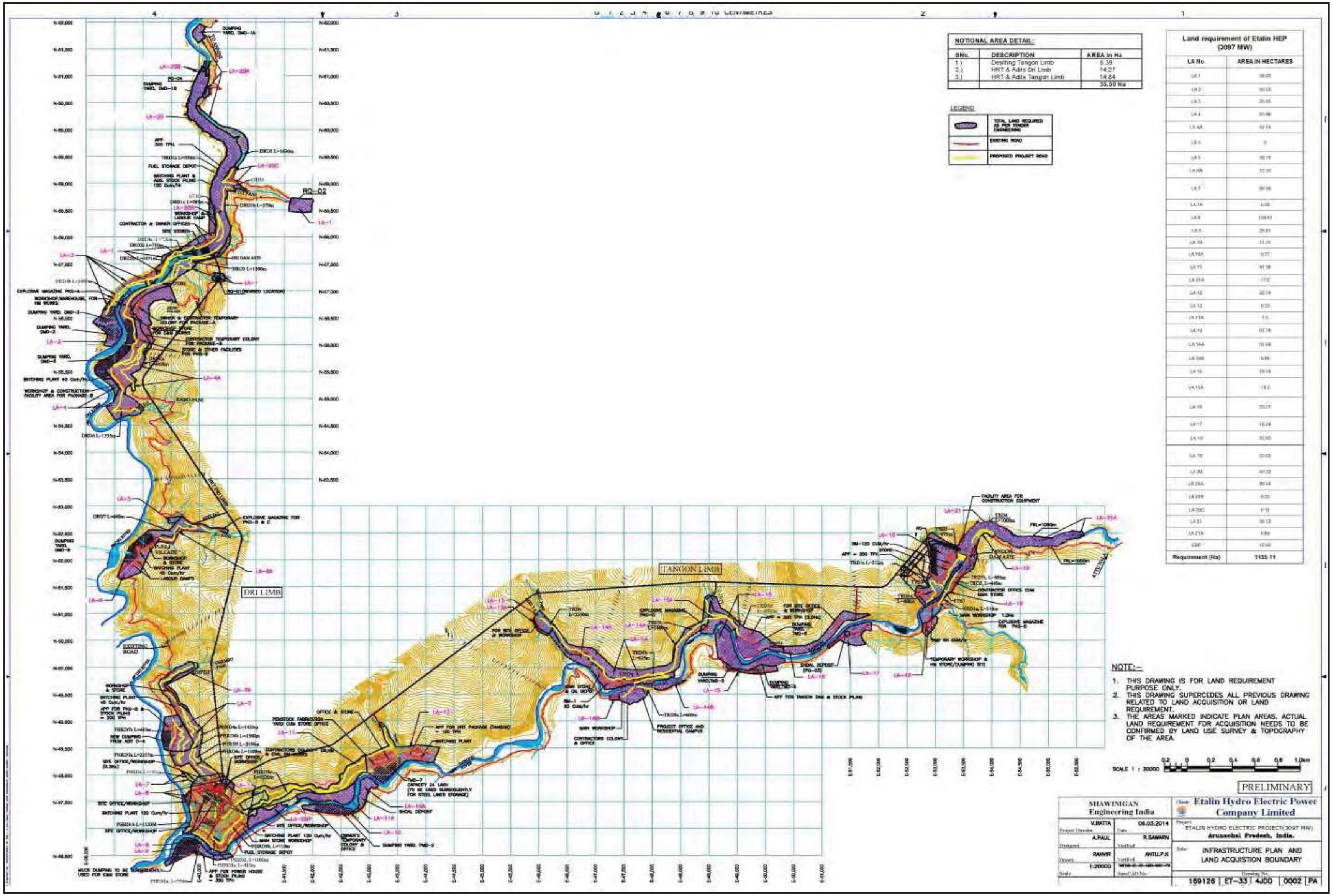


Figure 6.1: Layout map of Etalin HEP showing infrastructural facilities

Evaluation – Biodiversity Resources: Biodiversity status assessment of flora and different faunal groups showed record of 413 plant species, 159 species of butterflies,113 species of spiders, 11 species of odonates, 14 species of amphibians, 31 species of reptiles, 230 bird species, and 21 mammals within the proposed project study area. Among the faunal groups studied, secondary information for the study area was available only for butterflies, avifauna and mammals. Butterfly (159 species) species contributed 88.8% of the cumulative list of species for the study area (**Tables 5.11, 5.16 & 6.3**). Though the avifauna richness contributed 86.07% of the possible cumulative list, the species diversity estimated for the 87 species showed low diversity of H' 1.07 (**Tables 5.29 & 6.3**) and very low to low abundance status (**Tables 5.27 & 5.28**). Mammalian fauna of the study area shared only 50.6% of the cumulative species list and most of the species (15 species) were found in low abundance (71.4%) out of 19 species reported (**5.41 & 6.3**).

Though conversion of 1155.11 ha (Surface Land 1063.78 ha + Underground Area 91.33 ha) land area of forest habitat was identified as direct impact of loss of habitat (**Impact 1**) and floral diversity (**Impact 2**) and associated faunal groups (**Impact 3**), along with considering the mandatory proposed compensatory afforestation program, would qualify these direct impacts **as construction phase and moderate level of impacts.** Added, adapting proper ecological restoration of degraded forest patches and areas, recovered from temporary project use and implementing suggested biodiversity and wildlife conservation plan would compensate the loss of habitat and is expected to recover the species richness and abundance of faunal diversity of the project area after construction phase of the project.

Table 6.3: Species Richness status of different Faunal Groups of EHEP Study Area.

Biodiversity	Species Richness Study Area			Possible Cumulative Species	R% of Study Area Species
	Family	Genera	Species		
Flora			413	593	69.6%
Butterfly	6	77	159	179 (EIA)	88.8%
Moths	12	45	51	SS-NA	
Odonates	2	5	11	SS-NA	
Spiders	25	88	113	SS-NA	
Fishes	4	9	12	SS-NA	
Amphibian	6	12	14	SS-NA	
Reptiles	6	23	30	SS-NA	
Birds	55	138	230	237 (EIA)	97.0%
Mammals	15	19	21	42 (EIA)	50.6%

EIA – report 2015, SS – secondary Source, NA-Not Available, R% - Relative percent

H' - Species Diversity, SS-NA – Secondary Source - Not Available

6.5. PROJECT ASSOCIATED ACTIVITIES - IMPACTS ON BIODIVERSITY

6.5.1. Muck-Dump Generation and Handling – Impacts on Physical (land, air and water) and Biological Resources (habitat)

The project would generate substantial quantity of muck due to implementation of diverse project development activities. Since the project area is predominately undulating in nature the entire muck dump handling activities: excavation, collection, loading and transportation and storing in the dumping yards, are visualized to have impact on the physical (air, noise, water) and biological (flora & fauna) resources as follow:

Impact 4. Excavation and handling of muck would create significant quantity of dust emission which would deposit on the adjacent land area and vegetation cover and is likely to create habitat degradation – Direct and primary impact

Impact 5. Land degradation would indirectly lead to decrease of floral and faunal diversity

Impact 6. The muck dumps developed would create visual intrusion impact along the river limbs and in the forest landscape- Indirect and secondary impact

Impact 7. Development of large sized muck-dumps with steep slopes along the river side may restrict the movement of small mammals and their access to the river habitat - Indirect and secondary impact.

Evaluation – Muck and Dump Area: The project would generate substantial quantity of muck from excavation for various structures. The total quantity of muck-dumps generated due to excavation is estimated to be 108.9 Lac m^3 and the net quantity to be disposed to the muck dumping yards works out to be 95.00 Lac m^3. Considering land suitability and in order to reduce the lead distance, a total of 113.70 ha has been identified for muck-dump yard spread over 12 locations with 7 sites on Dri limb, 4 sites on Tangon limb and 1 site near powerhouse (**Table 6.4. & 6.5**). Considering the quantity of muck to be generated, extent needed for muck dump sites, which are identified along the Dri and Tangon limbs and power house areas and handling activities, the anticipated habitat degradation (**Impact 4**), decrease of fauna diversity (**Impact 5**), have been evaluated as moderate level of operational phase impacts. Other impacts, visual intrusion (**Impact 6**) and restriction of movement of small mammals (**Impact 7**) are indirect and long-term impacts. Implementing appropriate technical interventions at micro level site selection and structural management of dump and timely restoring the muck-dumps with suitable plant species can help in minimising all the impacts (see **Mitigation Chapter 7**.)

Table 6.4. Details on total quantity of Muck

Item	Quantity (Cum)
Total quantity of muck generated	16564523
Muck can be used as coarse aggregate	4829797
Total usable quantity	11734726
Source: EHEPCL- EMP Report 2015	

Table 6.5. Details of Muck Dumping Sites

S. No.	Dumping Yard	Plan area (ha)	Capacity (Lakh/cum)
	DRI LIMB Area		
1	DMD1	2.44	2.29
2	DMD2	4.28	5.81
3	DMD3	4.26	7.11
4	DMD4	**Not Required**	
5	DMD5	19.94	26.5
6	DMD6	13.4	9.58
7	DMD7	4.94	12.24
8	DMD8	16.97	24.69
	Sub Total	**66.23**	**88.22**
	TALO (TANGON) Limb area		
1	TMD1	**Not Required**	
2	TMD2	**Not Required**	
3	TMD3	**Not Required**	
4	TMD4	6.51	6.39
5	TMD5	13.31	25.76
6	TMD6	10.21	23.97
7	TMD7	9.94	13.97
	Sub Total	**39.97**	**70.09**
	Powerhouse Area		
1	PDM1	**Not Required**	
2	PDM2	7.5	4.84
	Sub Total	**7.5**	**4.84**
Grad Total		**113.7**	**163.15**

Total Plan Area = 113.70 Ha

Total Capacity = 163.15 lakh Cum

Total muck to be disposed = 117.35 lakh cum

Source: EHEPCL- E**MP** Report 2015

6.6 DUST AND OXIDES EMISSION- IMPACTS ON FOREST HABITAT AND FAUNA

6.6.1. Impacts of Construction Activities - Dust and Gaseous Emission on Vegetation and Faunal Diversity

Other than muck dump, all other civil construction activities like; excavation, landscaping, handling of construction materials (import, store, transporting to the construction site) and concert works for the construction of dams, power houses and power house complex, other proposed infrastructures and heavy movements of vehicles and equipment operations are found to be the major sources of dust emission (**Table 6.6.**). These activities generate enormous quantity of windblown dust particles (Particulate Matters) and gaseous (So2 & Nox) emission that would deposit on the adjacent forest habitats and impact the habitat quality and faunal diversity well beyond project area as follow:

Impact 8: Habitat degradation and loss of forest cover in the adjacent and or beyond the project area – Direct and Primary impact

Impact 9: Affect the species richness and abundance status of faunal species of the adjacent forest habitat- mainly the insect fauna and avifauna using ground and middle layers of vegetation cover- Indirect and secondary impact.

Evaluation of Air Quality: Monitoring for assessment of ambient air quality was carried at eight stations across three seasons (winter, summer and pre-monsoon), for four air components within the project area (**EIA Report 2015**). The summery results revealed that, all the components such as; So_2 values ranged from 5.6 to 8.9, NO_x 12.2 to 16.8, PM10 maximum of 27.1 and PM2.5 12.9 ɲg/m$^{3+,}$ were well within the permissible limits for annual and 24 hours time scale for the industrial, residential, rural as per CPCB and ecologically sensitive area as per MOEF &CC norms (**Table 6.6**).

Table 6.6: Summary Details of Ambient Air Quality Status Monitored in the EHEP Study Area

Air quality Parameters	Range - ɲg/m^3		Permissible Limits MOEF&CC Norms	
	Mim	Max	IN-RE-RU	ESA
SO_2 ɲg/m^3	5.6	8.9	Annual 50ɲg 24 hour 80	Annual 20ɲg 24 hour 80
NOx ɲg/m^3	12.2	16.8	Annual 40 24 hours 80	Annual 30 24 hours 80
PM_{10} ɲg/m^3		27.1	Annual 60 24 Hours 100	Annual 60 24 Hours 100
$PM_{2.5}$ ɲg/m^3		12.9	Annual 40 24 Hours 60	Annual 40 24 Hours 60

Source: Compiled from EIA Report (EHEPCL) RS ET Pvt Ltd 2015

IN- Industrial, RE- Residential, RU- Rural, ESA - Ecologically Sensitive Area, MOEF&CC – Ministry of Forest and Environment & Climate Change

Evaluation- Selected Faunal Diversity: the study area reported high richness of butterflies (159 species), moths (51 species) and spiders (113 species) species (**Table 6.3**) and except for butterflies (EIA Report 2015), there are no earlier studies on these taxa specific to the study area. Among the 87 species of the avifauna majority of them were found to use the ground and middle canopy layers and predominately insectivore species (**52 species- 59.8% - Table 5.34**). Even though, all the air quality parameters found to be within the permissible limit of MOEF&CC norms, the status discussed is pre-project scenario. Therefore. considering the spatial distribution of these faunal groups and magnitude of project construction activities, the above predicted impacts (**Impacts 8 and 9**) can be evaluated as highly significant construction phase impacts. Dust and gaseous emission being the most common and inevitable impact in any development of mega projects and minimization of construction phase impacts can be done only through adopting appropriate mitigation measures.

6.6.2. Drilling and Blasting for Coarse and Aggregates Quarry – Impacts of Noise and Ground Vibration on selected Faunal groups

One of the major sources of noise pollution is quarry activities which involves drilling and blasting to generate coarse and fine aggregates for the construction of all the civil works and roads. In addition, heavy machineries and vehicles will be used for excavation and transportation of the coarse and aggregates from at source to different end use sites. These activities will have some adverse impact on the ambient noise levels in the project area which would directly affect the selected faunal species;

> ***Impact 10: Change the normal behaviour (day to day activities) of major faunal groups of the project area – Secondary and indirect impact.***
>
> ***Impact 11: The impacts of noise and ground vibration would affect reptiles and ground dwelling small mammals in term of restriction of movement - Secondary and indirect impact.***
>
> ***Impact 12: Some larger groups of faunal species might move away and disappear from the project area and thereby reduce the abundance status- Primary and direct impact.***

Evaluation – Quarry Activities/Drilling and Blasting: The estimated total requirement of coarse and fine aggregates as construction material is 32.82Lac m^3 and 18.92 Lac m^3 respectively. Most of the requirement of coarse and aggregate will be met from the rock excavated from tunnels and underground works and the remaining will be quarried from identified sites for quarries. A total of about 10.75 Lac m^3 has been anticipated to be extracted from 2 Nos. of identified Rock Quarries (RQ). Similarly, the requirements of fine aggregates will be met from 4 Nos. of identified Shoal & Sand quarries (PQ). About 9.43 Lac m^3 is anticipated from the various identified quarries for fine aggregates and the rest will be obtained by crushing the potential muck generated from the underground excavation (Source: **EHEPCL Project report volume-I, Part-B, 2013).**

Evaluation of Ambient Noise level: Monitoring of ambient noise level study was carried out at eight stations across three seasons for day and night hours limits within the project area. The summery results revealed that, overall the noise level ranged from 55.9 to 61.8 dB (A) day time observation (**Table 6.7**).

Table 6.7: Summary Details of Ambient Noise level Monitored in the Project Study Area

Seasons	Range	Winter range	Pre-monsoon	Monsoon
	Minimum	57.0	56.4	55.9
	Maximum	60.9	60.5	61.8
Overall range	Minimum 55.9 and Maximum 61.8			
Limits in (dB (A) Leq	Category of Area (Prescribed Standards)			
	Industrial area	Commercial area	Residential area	Silence Zone
Day Time	75	65	55	50
Night Time	70	55	45	40

Source: Compiled from EIA Report (EHEPCL) RS ET Pvt Ltd 2015

Evaluation - Impact on Faunal groups: However, the project area is located predominately in forest habitat and inter spread with villages, the observed limits of noise level was slightly on the higher side for residential (rural) and forest (silence zone) during both day and night hours, compared to the overall range prescribed as standards for industrial and commercial areas. Therefore, the pollution impacts will affect the selected faunal species (birds 230 species, reptiles 31, and 21 species of mammals) in the form of change in daily activities (**Impact 10**), restricted movement (**Impact 11**) and local disappearance (**Impact 12**). Further, the abundance status of bird species showed that almost all the species fall under very low to low categories in the study area (**Table 5.30 & 5.31**) and mammalian fauna was also estimated to be in very low abundance (0.106 captures (animals)/1552 camera nights - (**Table 5.43)**. Even though, these impacts are expected to last for 84 months (seven years) of construction period, it would be of moderate level of impacts due to noise, which need to be attended with some technical and managerial interventions (**Ref Chapter 7**).

6.7. ROADS, HEAVY VEHICLE AND EQUIPMENT MOVEMENTS – IMPACTS ON FAUNAL GROUPS

6.7.1. Unregulated Vehicle Movement - Road Mortality on selected Faunal groups

Construction of network of new roads and widening of existing roads and frequent movement of heavy vehicles and heavy equipments for the construction activities and transportation of lobous and technical staffs, in the project area is anticipated to impact upon the selected faunal groups of the project area, like

> ***Impact 13: Fragmentation of natural habitats and isolation of populations of lesser mammals and herpetofauna which are reluctant to cross the roads - Indirect and long-term impact.***
>
> ***Impact 14: Herpetofauna and smaller mammals are prone to accidents / road kill due to intensive vehicle Movements-Direct or secondary impact.***
>
> ***Impact 15: Intensive movement of vehicles will reduce the birds and other mammal species richness and abundance in the habitats along the road sides***

Evaluation- Network of Roads and Vehicle Movements: The proposed project has plan to develop additional network of roads of 50km length within the project area to approach various locations of project sites. In addition, 35km stretch of existing roads within the project area, are planned to be widened and strengthened for the movement of heavy equipment and machinery (Source**: EHEPCL Project report Volume-I, Part-B, JULY 2013)**

Evaluation- Use of Heavy Equipments: All the project construction activities will involve use of many types of equipment / machineries, which can be grouped in to heavy, supportive and miscellaneous. The compilation of equipments data showed that, a total of 28 heavy and 13 supportive types of equipments will be in use with 50 and 16 capacities. In addition, many other miscellaneous accessories will be used (**Table 6.8**). It is understandable that the construction of various activities in both the limbs will happen concurrently in a phased schedule. Hence, many equipments may be reused. The DPR of EHEPCL does not provide information on actual number of equipments will be required for the construction considering the reusing of equipments. These uses of equipments, their movement and operation are predicted to have impacts.

Table: 6.8. Summary Details of Equipments in use for all Project Construction Activities

S. N.	Heavy Equipments/ Machineries	Types/ Capacity	No of Units	S. N.	Supportive Equipments	Types /Capa city	No of units
1	Alimak Raise Climber	1	4	1	Rock Bolder	1	2
2	**Excavator**s: Capacity- 3.0/2/1.57 cum	3	16	2	Gantry shutters	1	5
3	Rear end Dumpers 25 T/15 T cap/ Bobcat excavator/	3	270	3	Rib Bending Machine	1	7
4	**Dozers:** Dozers/ Crawler dozer / 90 HP/324 HP/ Tyre Doser	3	45	4	Ventilation Blower (110 kW)	1	5
5	Jack Hammers 120 cfm	1	193	5	Tractor Trollies	4	14
6	Rock bolter (for anchoring on slopes)	1	7	6	Jet Grouting set	1	2
7	Wagon drill 400 cfm	1	96	7	Motor Graders	1	5
8	**Compressors** 100/300/450/500/600/1000/1450/1600 cfm /Diesel	8	91	8	Water Sprinkler	1	5
9	Two -Boom Drill Jumbo	1	18	9	Penstock fabrication yard	1	6
10	**Loader:** Front and Back hoe - 2.3 cum	1	21	10	Sand blasting equipment	1	2
11	Concrete pump 40/ 25 cmu/hr	2	21	11	Hand held Rock drills	1	18
12	**Transit Mixers** (6 /4cum capacity)	2	126	12	Scissor Platform	1	2
13	Hydraulic Platform/Truck Jumbo	1	9	13	Steel Shutters	1	5
14	**Excavators:** Hydraulic Excavators (3 /105/1.84 cum)/ Bobcat excavator 0.5 cum	4	24		Total	16	78
15	Grout Pump/200cfm	1	49		Other Accessories lot in numbers		
16	Concrete Placer 1cum	1	11	1	Needle Vibrators (65mm dia. Needle)		Lot
17	Shotcrete Machine	1	21	2	Blasting Accessories		Lot
18	D.G. Set 500/1010 kVA	2	17	3	Dewatering pumps of different capacity		Lot
19	Tower Cranes (10 T – 3 cum /18T-6cum bucket	2	6	4	Grouting Accessories		Lot

S. N.	Heavy Equipments/ Machineries	Types/ Capacity	No of Units	S. N.	Supportive Equipments	Types /Capacity	No of units
20	**Cranes :** Mobile Cranes (35T)/ 40T/8/10T/ 8MY & Rough terrain crane / Gantry crane (30T capacity)	6	16	5	Steel Formwork and Vibrators		Lot
21	**Winch**: Capacity of 10T/and 30T	2	10				
	Others						
22	B & M plants (160 cum /hr)	1	1				
23	Aggregate crushing plant- 500 T/hr	1	2				
24	Collapsible hydraulic gantry	1	2				

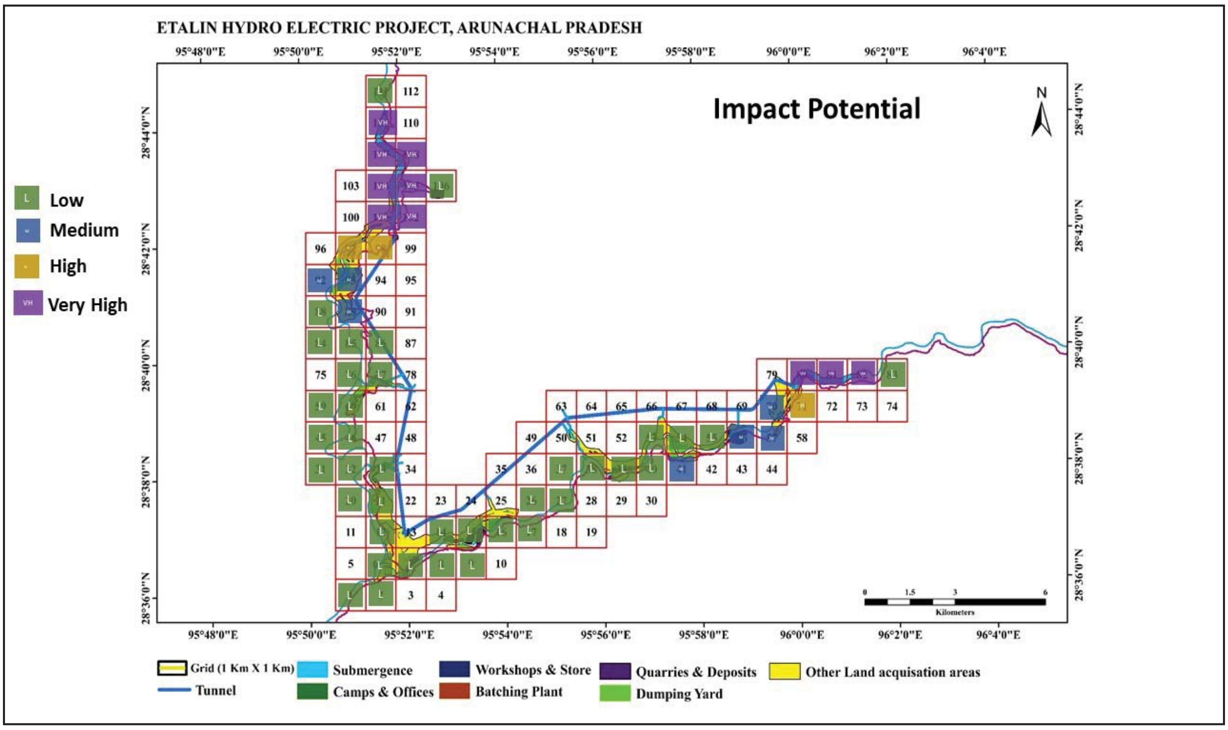
Source: compiled from: EHEPCL- Detailed project report (final), volume-I, Main report Part-B, 2013

Evaluation- Status Faunal Diversity: This study identified presence of 14 species of amphibians, 31 species of reptiles, 230 species of birds and 21 mammalian species within the project study area. The species which are shy and reluctant to cross the roads may get isolated into small population because of construction of 50km of new roads and widening of 35 km of existing roads (**Impact 13**). Intensive vehicle movements and use of the equipments during the construction phase are likely to increase road mortality of herpetofauna as well a small mammal (**Impact 14**). The bird species, which are dependent on forest habitat along the road sides are expected to decrease in their richness and abundance (**Impact 15**). Therefore, these impacts should be mitigated / tackled with some managerial regulation and technical measures suggested in mitigation chapter.

6.8. IMPACTS ON AQUATIC ECOLOGY

6.8.1. Impact Potential of the EHEP with respect to Aquatic Biodiversity

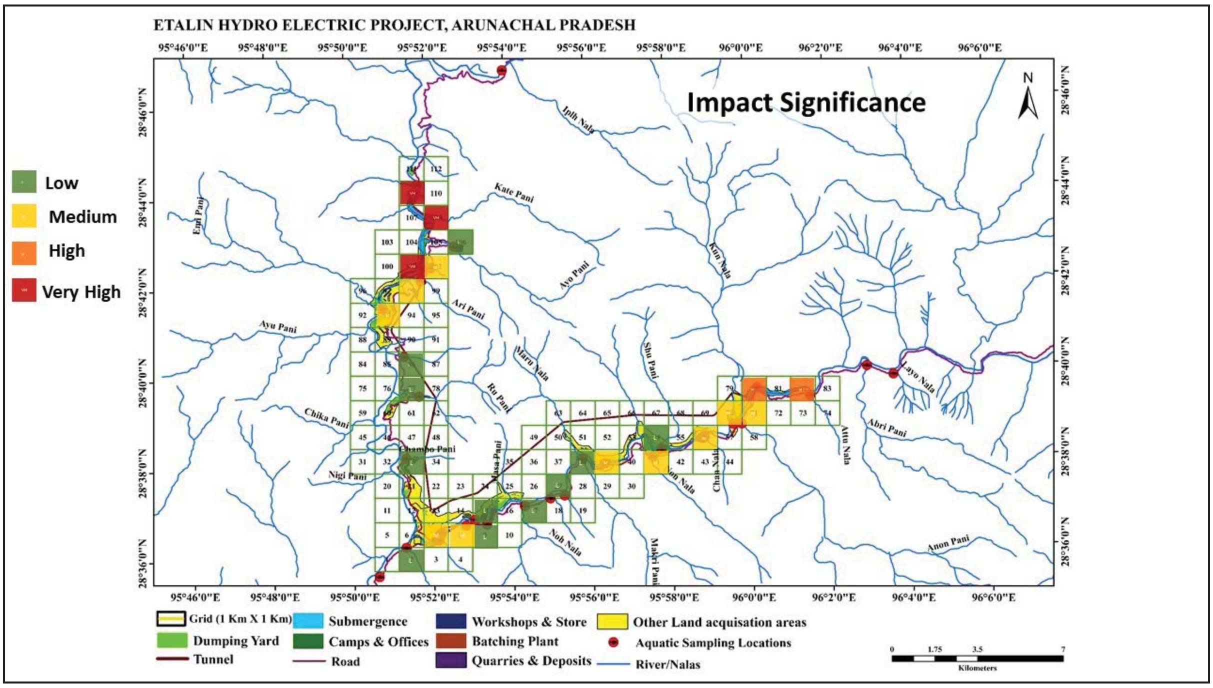
The impact potential of the EHEP was assessed for grids containing the main stem of Dri and Tangon river as well as their major perennial tributaries (**Map 6.3**) using the criteria defined previously. Grids containing the proposed dam, submergence areas and immediately downstream of the proposed dams (possible dry river stretches) have very high to medium impact potential values. The inflow of tributaries in most of the grids below the dam might have the potential to diffuse the dam impacts on the flow regime, contributing to low impact potential values. Also, relative to the dam and submergence areas, the impacts of muck disposal into river would be less. It should be noted that the impact potential of the dam and associated activities has been done only on the basis of their presence/absence in the grids. It is highly likely that the impact potential values calculated here are an underestimation of the actual impact potential, which would be only quantifiable with detailed data on the natural flow regimes and how they would be altered due to the dams.



Map 6.3 Impact potential of EHEP w.r.t. aquatic biodiversity

6.8.2. Significance of the Impacts of EHEP on the Aquatic Biodiversity

This exercise indicates relative ranking of impact significance on biodiversity in the two basins taking into consideration the biodiversity values and impact potential values of the sampled grids. It clearly outlines that different areas of the study area will receive variable levels of impacts if the current hydropower plan is implemented (**Map 6.4**). The negative impacts of the EHEP on the aquatic biodiversity will be highly significant (very high-high impact significance) in both the basins due to the dam and submergence areas, which would cause river fragmentation and convert lotic habitats to lentic habitats. In the rest of the areas, downstream of the dams, several areas will be subjected to impacts of medium significance due to the downstream impact of dams on the flow regime as well as other activities such as muck disposal. Several breeding/congregation sites as well as migratory routes of long-distance migrants would be negatively impacted due to reduced flows and the barrier effect of the dam.



Map 6.4 Significance of impacts of EHEP on the aquatic biodiversity

6.8.3. Impacts on Habitats - Water Quality and Physical Changes

Barriers, such as dams dramatically decrease the native fish diversity and dissolved oxygen content, making it unsuitable for other aquatic life, especially periphytona and benthic invertebrate community. Fish and other aquatic species population get isolated due to barrier effects of dams. In the case of cold-water fishes, they are much specialized in their habitat, diet and local environmental preferences, therefore, they have very restricted range of distribution. Any hydrological regulation would impact their movement, fragmenting the genetic flow between population, reducing feeding and spawning habitats, thereby putting them closer to extinction. The environmental consequences of dams are numerous and varied, and includes direct impacts to the biological, chemical and physical properties of rivers and riparian (or "stream-side") environments.

Apart from blocking fish migrations, it completely submerges fish spawning grounds such as confluence of tributaries, reophilic habitats and run habitats. The dam also traps sediments, which are critical for maintaining structural integrity of running water ecosystem.

Another significant and obvious impact is the transformation upstream of the dam from a free-flowing river ecosystem to a lacustrine habitat. Changes in temperature, chemical composition, dissolved oxygen levels, nutrient status, productivity, nutrient cycle and the physical properties of a reservoir are often not suitable to the aquatic plants and animals that evolved with a given river system. Indeed, reservoirs often host non-native and invasive species that further undermine the river's natural communities.

Within the study area, the upper reaches of the reservoir may not be affected very much as the original riverine conditions. Downstream of the dam the flow rate in the river will depend on the amount of the compensation flow. Water volume is considerably reduced during the dry season. Due to decreased water discharges, water temperature will rise in daytime and decline sharply at night. Both the river Tangon and Dri the water quality will affect in the power house area such as (Mayo pani, confluence of Dri and Tangon river), both the dam construction area (dam axis), dumping yard.

Sediments which will be deposited during construction decrease the dissolved oxygen level of the water, and increase the water temperature.

6.8.4. Assessment of Impacts on Aquatic Biodiversity

With respect to aquatic biodiversity, fishes such as snow trout, catfish and loaches may be pulled into the intakes and get killed. Even riverine fish adapted to fast current may be lost. Benthic insects – a primary food for many fishes will be highly affected by reduced flow rates. Mahaseer (Tor sp) are known to be affected directly by the changes in their habitat, which leads to stunted growth, prone to diseases and parasite infestation and thus resulting high mortality.

During monsoon (may, June, July) season and heavy rainfall, some fish do migrate from main river to the streams such as (anon pani, ayo pani, shu pani, achali basti nala, makhri pani, chambo pani, noh nala, mayo pani, kabo pani, ru pani, emi pani, ayu pani, aha pani, aru pani, ayo pani, illi pani) for laying eggs. Road cuttings and dam construction may cause lot of change in the channel morphology, which may destroy spawning ground and obstruct migratory route. The resident species may congregate in the tail water release site. Fish from upstream will occasionally sweep downstream during the monsoon, stay in the tail water or swim further downstream. The dam will obstruct the route of the long and mid-distance migratory fish. Upstream migrants will arrive at the dam site during the flow phase. Long distant migrants species will be most affected by the dam. These species will abandon the original pool and colonize deep pool regions downstream or upstream. Populations of snow trouts are less affected, as they make a small-scale migration to tributaries to breed in clear and cool water during the monsoon and return to the main stream during the low flow period.

During the construction phase, the main impacts will arise due to clearing of vegetation and earthmoving activities, which will mobilize sediments, causing them to be washed or blown into receiving watercourses. Increased sediment loads will have two consequences – firstly turbidity will increase, affecting visual predators, fish and filter feeders, and secondly, sediments will settle out causing cobbled substrates to become embedded. This will affect species with a high requirement for clean water and clear, cobbled substrates. Migration of fish may be affected by the design of the bridge and road cutting beside the River. During the construction phase, there may be a loss of sensitive species.

During the operational phase, underground blasting and transport of ore and slurry will commence. The impacts listed for the construction phase are likely to be on-going (although their magnitude may decrease slightly. It is possible that there will be a further loss of sensitive aquatic species as water quality and habitat integrity decline further. The waterfall tributary is likely to be affected by decreased flows and loss of habitat (including waterfalls during drier periods). With the influx of people, the introduction of alien fish, which might prey on indigenous species, cannot be ruled out.

There are many impacts that have been visualised and discussed in detail, related to impacts on River Habitats - Water Quality and Physical Changes (**Refer section: 6.8.3**) and Impacts on Aquatic Biodiversity (**refer Section 6.8.4**). This being r project and highly dynamic and sensitivity of the aquatic ecosystem, maintaining the environmental flow or e- flow during the post construction and operational phase is highly crucial. Taken into consideration of the ecosystem sensitivity, selected mitigations in the form of technical interventions such as: **Waste Debris Dump management, Maintaining Stream**

Morphology, and Domestic Solid Waste Disposal are suggested to mitigate some of these impacts (**see Mitigation Chapter 7**).

6.8.4.1. Impact of construction and widening of Roads

Though the impact of new roads and widening on selected faunal groups discussed in the above **Section 6.7.1,** the following are the additional impacts of road construction activities on forest and aquatic habitats:

> ***Impact 16: Damage to the forest habitat and faunal diversity along the road on riverside slopes due to runoff debris***
>
> ***Impact 17: Runoff debris reaches the river system and impacts the bathymetry, sedimentation problems and overall aquatic ecology of riverine habitat.***
>
> ***Impact 18: The road cutting due to construction of new roads across the streams will impact the migration of fishes from the main rivers to streams to lay eggs.***

Construction of new roads to a length of 50km and widening of existing roads for 35km is visualized to have impacts on both the forest and riverine habitats. Dumping of the excavated waste debris with larger and heavy boulders and earthen material along the river side slopes will roll down and completely damage the vegetation cover of forest habitat/bank vegetation (Impact **16**) and finally reach the river system and changes the bathymetry and increase the sedimentation load (Impact **17**). Hence proper **Waste Debris Management System** needs to be followed to address the impact on both the habitats. (**Ref -Chapter 7**)

Added, to the above mentioned impacts, construction of roads across the streams will form road cuttings that would stop the local migration of fishes from the main rivers to the stream systems to lay eggs during monsoon season (***Impact 18***). This can be mitigated by giving importance to construct culverts/bridges even across small streams to M**aintain the stream morphology** and free migration / movement of fishes (**see Chapter 7**).

6.8.4.2. Impacts of Hazardous and Domestic Waste Disposal – River system

Many of the proposed project construction activities form major sources of different kinds of effluents and most of them are hazardous. Other waste disposals include sewage and solid waste from the labour camps and project staff colony. Haphazard way of disposing these wastes, especially hazardous waste expected to have serious impact on both the terrestrial (forest) and aquatic (river) environments.

> ***19. Pollution and degradation of the forest habitat and indirectly affect terrestrial biodiversity***
> ***20. Solid and effluent disposal and dispersal into river system will impact water quality and associated aquatic biodiversity especially fish fauna.***

Around 1155 heavy equipments/machineries of different capacities are estimated to be in use of all the project construction activities (**ref section 6.7.1 - Evaluation- Use of Heavy Equipments**) and at present estimation of the quantity of effluent that will be generated is not possible. Hazardous waste will be generated during construction phase from machinery and equipment using fuel, lubricating oil, batteries etc. disposal of waste oil drums, used oil, maintenance and washing of equipments and vehicles are the sources of activities that will surely impact the project environment. Similarly, around

12,000 outside migrants (project people) estimated to be involved in project construction activities. Sewage from the labour camps and colony and solid waste generated from both will be biodegradable as well as non- biodegradable. Overall indiscriminate disposal all the waste surely will significant impact (**Impact 19 and 20**) at least during construction phase. Hence, in addition to establishment of ETP for sewage disposal and well structure waste management, additional management systems are needed for complete mitigation (**See Chapter 7**).

6.9. IMPACT ON THREATENED BIODIVERSITY

6.9.1. Overall of Project Associated Construction Activities - Impacts on Threatened Fauna

Presence of any threatened faunal species in the study area of the project is likely to get impacted due to the above discussed all project related activities (excavation, construction and transportation, storing and handling of project materials and maintenance) in the form of:

Impact 21: Loss of specific habitat of the threatened faunal species of the project area- Direct and primary impact.

Impact 22: Overall habitat degradation, fragmentation, mortality and population decrease of threatened faunal groups – due to overall project activities– Direct and indirect impacts.

The assessment of impacts of project on threatened species was discussed considering the species that fall under highly threatened categories such as; Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) of IUCN Red list and Schedule I species of IWPA (1972).

Evaluation - Flora: this study reported diverse floral species of 413, belonging to 110 families and 275 genera, and this included only *Piper pedicellatum* a shrub species listed as Vulnerable in IUCN Red List. However, in the present study area it is found in abundance and estimated as very high-density species and ranked second under Prominence Value Index of shrubs (**Table 5.3**). Therefore, local abundance does not necessitate any specific conservation plan for this species.

However, the floral richness of the Dibang valley which covers large extent of area, reported very high conservationally important threatened and endemic flora of Arunachal Pradesh which needs to be considered for conservation (**See: Box 6.1**). Keeping the short survey of the present study, it is very important to carry out intensive survey specific to record epiphytic flora, like orchids, pteridophytes, lichens and fungi to develop arboretum / botanical garden exclusively under floral species conservation plan (**see Chapter 7 – Conservation Plan)**

Box 6.1: Floral species of Conservation Importance - Dibang Valley (source CIA & CCS – Report 2016)
Orchids: • Out of 199 orchids species documented in Dibang basin, 150 are epiphytes and 46 are terrestrial orchids, while three species were of mycotrophic habit (living in association with mycorrhiza). • *Gastrochilus calceolaris,* and *Paphiopedilum fairrieanum* are listed under Critically Endangered category as per IUCN Red List, while *Bulleyia yunnanensis* has been listed under Endangered category in Red Data Book of BSI. It has listed *Paphiopedilum fairrieanum* under EN category while *Galeola falconeri* and *Vanda coerulea* have been placed in indeterminate and rare categories. • Six orchids reported from Dibang basin are endemic to Arunachal Pradesh viz, *Calanthe*

densiflors, Dendrobium cathcartii, D hooherianum, Eria ferrugines, Galeola falconeri and *Paphiopedilum fairrieanum*.

Threatened species:

- In Dibang basin 30 plant species are under different threat categories as per IUCN or under Red Data Book of BSI. According to IUCN category four species *Dipterocarpus gracilis, Gastrochilus calceolaris, Paphiopedilum fairrieanum* and *Saurauia punduana* have been listed as Critically endangered (CE). Eight species under Endangered (EN), five species as Vulnerable (VU) and three species as Near Threatened (NT).

Endemic species:

- Fifty-three species that are endemic to Arunachal Pradesh have been reported from Dibang valley and they belong to 28 families and 42 genera.

Evaluation - Butterfly: the project area reported 159 species of butterflies, of that only three species, Pale Jezebel (*Delias samaca Moore*), Scarce Jester (*Symbrenthia silana* de) and Spotted Black Crow (*Euploea crameri nicevillei*) were listed under Schedule 1 part 4 of IWPA (1972) – **Annexure 5.4.** Considering the impacts of dust and gas emission, noise and vibration due to project related activities (excavation, drilling, blasting, vehicle movements and use of heavy machineries) followed by habitat loss and degradation, it is very important to conserve butterfly species, as they help in pollination. This can be possible through development of open and closed butterfly parks at few sites, in the recreational gardens planned to be developed, in the areas like; office premises, staff colonies, school and hospital areas.

Evaluation - Herpetofauna: the survey reported 14 species of amphibians and none of them fall under the three categories of IUCN (CR, EN, VU) and Schedule I of IWPA. All the species reported belong to Data Deficient (DD) and Least Concerned (LC) categories of IUCN list (**Annexure 5.8**).

Out of 31 species of reptiles listed from the study area, only three (Bengal Monitor Lizard (*Varanus bengalensis*; Schedule I species), Burmese Python (*Python bivittatus*; Vulnerable and Schedule I) and King Cobra (*Ophiophogus hannah*; Vulnerable) species were identified as conservation importance, under IUCN and IWPA list (**Annexure 5.8**). Since the presence of these three species was reported based on the social survey, their abundance status was not known. Therefore, the magnitude of impacts of project activities on the threatened reptile species may not be significant. However, common mitigation measures are suggested to minimize the road mortality of herpetofauna, which is likely to help to protect these species in the study area.

Evaluation – Birds: Out of possible 237, including 230 species reported during this study. five species were listed as schedule I under IWPA, seven species as near threatened under IUCN Red List, and seven species that were endemic to Arunachal Pradesh. Therefore, overall 16 species have been identified as species of conservation importance of the study area. Among the list, except for Kalij pheasant - *Lophura leucomelanos* (11 birds) - Schedule I of WPA (1972)*,* White-naped yuhina *Yuhina bakeri*- (18 birds), and Yellow-vented warbler -*Phylloscopus cantator* (nine birds), both endemic species, the remaining were represented by only one or two birds (**Table 5.38**). The list of species belongs to diverse foraging guilds and record of few individuals (low abundance), it is not feasible to suggest any species specific conservation plan. Habitat development and restoration of degraded forest patches and effective awareness program to control bird hunting by the local people are some management options that would help in conserving the overall avifauna as well as the threatened species of the project area.

In addition, under species group conservation, providing nesting niche in the form deploying nest boxes to support the hole nesting species of the study area can be done under experimental basis and that can be extended followed by monitoring study.

Evaluation- Mammalian Fauna: Among the 21 mammal species reported in the study, five are listed as threatened under different categories of the IUCN Red list (**Table 5.45**), while three species were listed as Schedule I of the Indian Wildlife Protection Act (IWPA, 1972) namely, Himalayan Serow - *Capricornis thar,* Asian golden cat- *Catopuma temmincki* and Leopard cat *Prionailurus bengalensis*. Among these species except for *Prionailurus bengalensis* - Leopard cat (33 camera trap captures), rest of the species were with very low capture rate.

The secondary information added 10 more threatened species, which are inhabiting the upper reaches of Dibang valley, and none of them reported in the study area (**Table 5.46**). Added, the social survey on hunting revealed that, the ethnic hunters of the study area have to walk 2-4 days to hunt the species like; Takin, Musk deer, Red Panda, Bear, Goral, Himalayan Serow and Wild Dog, which indicates that these species are not using the habitat in the immediate vicinity of the project area (**Figure 5.12**). Despite the low capture rate of the species of conservation significance, it is very important to carry out intensive long term monitoring of threatened mammals within the study area and also well beyond in the Dibang Valley, which also supports, another 10 RET species of higher altitude (**Table 5.46**).

6.10. BIODIVERSITY USE VALUES OF LOCAL PEOPLE

6.10.1 Loss of Forest Habitat and Impact on Natural Resource Dependency of Local People

The requirement of land for the project development is **1155.11 ha** and most of the forest habitat come under Unclassified State Forest (USF) and Community Forest Lands. The locals being ethnic groups and having rights to use forest resources, the loss of forest land is visualized to impact on resource dependency of the local villages in the line of:

> ***Impact 23: Loss of forest and community lands expected to increase the biotic pressures on the adjacent forest areas by the relocated project affected villagers - Indirect and Secondary impact***

Evaluation- Project Affected Villagers: Social survey identified about 20 villages, 178 families and 839 people are likely to be affected due to the proposed hydropower project. Even though, part of the affected families planned to settle in Anini, and plan of number of families to be re-located in other areas is not known. Study on source income of the PAFs revealed that, 50% of the people directly or indirectly depend on the forest-based resources. Therefore, displacement or re-location of project affected families intend to depend on the natural resources in the adjacent forest area and thereby affect the biodiversity values in the forest habitat of outside project area. Proper livelihood options to generate permanent incomes in terms of job opportunity in the project and self-employment through CSR activities would minimise the impact on forest based natural resources in the additional forest areas (**Impact 23**).

> **Impact 24: Loss of forest habitat and impact on forest resource decrease and accessibility**

Evaluation- Biodiversity Use Values of Local People: Social survey, reported that more than 50% of the PAFs depend on natural resource for income generation. Within the natural resource collection 86.0% depend on NTFP, 39.77% hunting, 37.99% fish collection and 35.75% collect timber for their requirements. Collection of NTFP include 24 edible and fodder plants, and eight species of medicinal plants (**Tables 5.51, 5.52, 5.53**). The locals also hunt 30 and 43 species of mammals and birds respectively for their protein requirements respectively (Annexures **5.13 & 5.14**).

Evaluation of Accessibility of Natural Resource: As per information gathered from local people during field survey, bamboo collection and hunting will be affected due to proposed project as bamboo garden /plots would be affected under various land acquisitions. As mentioned earlier, bamboo plays a very important role in terms of their livelihood, while culturally also it has very high significance **(Table 6.9)**. Every clan has its own reserve bamboo garden / plot on community owned forest. So, after resettlement they will lose access to community owned bamboo gardens. People also complained that they will have to travel far off places for hunting, once the project starts commissioning. However, project will have low impact on hunting as people in general travel to far off places for hunting, in addition to the employment generation by the project, that will reduce stress on hunting. *Paris polyphylla* and medicinal plants such as *Coptis teeta* will have no impact, as such due to project activity because it is collected from alpine meadows, which is way beyond project area. Overall the impact on natural resources found to low in all the cases, except for bamboo (**Impact 24**).

Table 6.9. Potential Impact of proposed project on Local People's Resource Collection

Activities	Access	Impact	Remark
Fodder Collection	No change	Low	Collected near Forest Fringes near roadside
Wild Edible Plant Collection	No change	Low	Collected near Forest Fringes near roadside
Medicinal Plant Collection	No change	No	Collected from alpine meadows and mainly *Coptis teeta* is collected
***Paris polyphylla* collection**	No change	No	Collected from alpine meadow
Bamboo Collection	Decrease	Medium	People will have limited access after Resettlement
Cane Collection	No change	Low	Collected from outside PA
Hunting	Decrease	Low	Constructional activity due to project will disperse animals and hunters will have to travel greater distance for hunting

As per the people's response, among the natural resources they depend, expect for that medicinal plant, *Paris polyphylla* collection, the accessibility and resource depletions of rest of the resources will have low to medium impacts.

6.10.2. Labour force related Biotic Pressure- Impact on Forest Resources and Faunal Species

The construction of different project structures planned for seven years and requires few thousands of manpower from outside the project area. Involvement of outside work forces for the project development activities visualized that, in addition to establishment of labor colonies in the forest land area, the following impacts on forest resources and faunal species and, many impacts of social aspects are visualized and listed below;

Impact 25: Migrant depend on forest-based resources like; NTFP and tree cutting for timbers and fuel wood and thereby depletion of local resources and conflict between the migrant labors and local villagers.

Impact 26: Involve in illegal activities like; and poaching of birds and animals – Direct impact on selected faunal groups and resource crunch for local ethnic hunters.

Impact 27: Aquatic and terrestrial habitat degradation - domestic sewage disposal

Evaluation- Migrant Work Forces: Manpower requirement for the project construction activities is estimated to be about 3000 people. Based on experience of similar projects and some assumptions (technical staff emigrating into the area, family of workers both the husband and wife, only husband will work, service provider's family and family size – 5 members etc) the estimated migrants are to be around 12,000 people which is 149.9% increase of the human population during the construction phase of the project.

The direct impacts project due to loss of forest habitat on natural resource dependency of the local villagers found to be low in most of the cases, and medium in bamboo (**Table 6.9**). However, sudden increase of 150% of migrant population is predicted to have additional direct impacts (**Impacts 25 and 26**) on biodiversity resources due to illegal collection of NTFP, timber, bamboo and hunting of birds and animals. Added to that, considerable amount of domestic sewage disposal is expected to degrade the forest and river and stream habitats of the project area (**Impact 27**). Strict enforcement of management intervention to stop all the illegal activities would completely reduce the above discussed impact. In addition, very effective awareness education to the locals and migrants is suggested to minimize the hunting pressure.

Impact 28. Influx of large number of migrant population- Impacts on the cultural values of the local community

Evaluation – Cultural Values: The local people of the project area belong to Idu Mishmi tribes and **t**hey are traditional food gatherers, i.e., gather wild food. Idus have very elaborative rules and taboos regarding hunting of animals. "Mithun" a domesticated form of wild gaur is reared and is allowed to forage in the forest and it plays an essential role in socio-economic and cultural life of the Idus. Some of the impacts discussed by the locals specific to cultural values are intercultural mixing and influx, traditional grazing practice of Mithun, hunting culture, illegal settlements and women safety because of likely domination of large number of project (**Table 5.57**). Therefore, mitigation measures need to be devised through interaction between project proponents and high-level village committee to mitigate the impacts on cultural values of the local people as well as monitoring of Inner line permit of the migrants for illegal settlement (**Impact 28**).

6.11. Impacts on Ecologically Sensitive Area –ESA

6.11.1. Vicinity of Ecologically Sensitive Area to Project location - Impacts on Ecologically Sensitive Area

Presence of any area of conservation significance, such as Wildlife Sanctuary, National Park, IBA, wetlands, wildlife migratory route and heritage sites, in the close vicinity of the project site is expected to have some direct and indirect, impacts specifically on faunal species as well as overall habitat status. Possibilities of occurrence of impacts on ESA, entirely depends on the spatial distribution and the type of project. Therefore, the existing ESA and their location are discussed to predict the likely impacts.

Evaluation –ESA: Secondary information on area of conservation significance/eco-sensitive zones revealed that, no such Eco-sensitive areas are located in the close vicinity of the project site i.e., within 10k radius. Analysis of spatial distribution of the area of conservation significance showed only two Protected Areas located in the close vicinity of the project site *viz*., Dibang Valley Wildlife Sanctuary (DWLS) and Mehao Wildlife sanctuary (MWLS). However, the linear distance between the tail end of the submergence of Dri – Dam and Tangon Dam to DWLS was 12.8 km and 12.2 km respectively, towards north-west direction of the northern boundary. This being a hydro power project, no any impacts are likely to occur in the up-stream of the dam sites and in the catchment area – where the DWLS is located. Similarly, the location of MWLS, which is in the southern direction was 40.4 km from the proposed power house, and the Dibang river, that flows from the confluence of Dri and Tangon, where the power project is planned, is also not passing through the sanctuary area. The longer distance and location of both the sanctuaries show that, the hydropower project is not likely to affect both the ESAs (**Map 6.5**).

6.11.2. Project location on Wildlife Corridor – Impacts through Restriction of Movement of Key Species

Wildlife Corridor-Tiger movement: Status of mammalian fauna in the project area confirms to be of low abundance. Though, many large to medium sized mammals are reported in the upper reaches and in Dibang Valley, *viz*., larger cats (Clouded Leopard, Common Leopard, Snow Leopard and Bengal tiger) and other ungulates (Mishmi Takin, Alpine Musk Deer and Red goral), none of them are reported in the study area due to the location of the project in the lower altitude (600 to 1500) which seems to be not suitable for them due to the following reasons.

Existing Biotic pressures – Project Area: Presence of 22 villages within the project area along the Dri and Tangon limbs and associated shifting agriculture, collection of NTFP, timber, bamboo and cane collection, and other resources leading to degradation of the habitat quality in the proposed project area. Further, regular hunting activities could be a significant factor that reduce the faunal diversity and abundance. Even though, they have traditional right to use the forest resources including hunting of animals, these anthropogenic pressures might be limiting the movements of tiger through the dri and Tangon river limbs because of low prey base.

Existing Vehicle Traffic - Project area: The existing traffic density estimated at eight sampling locations within the project area across three seasons showed traffic density of 479 vehicles/hour (**Table 6.10**). Irrespective of types of vehicle, in any given season (three season)/any location (eight locations), a total of 20 vehicles/hour move in the project area. Extrapolation of the vehicle intensity, 20 vehicles x 8 hours x 365 days showed that a total of 58,400 vehicles move in the project area in a year. The very high intensity of vehicle movements in the study area could also be one of the factors restricting the movement of tigers in the project area.

Local's Perception: Social survey and interaction with the local hunters to list the species they hunt also confirm that, though they do not hunt tigers due to cultural belief (the *Idu Mishmi* community do not hunt the tiger as it is considered as next to human kin – **Refer section 5.4.3.4**), they opined that, tiger can be seen only after 2-4 days walk from the river limbs to the upper reaches of Dibang valley and they are never seen in and around the project area.

Table 6.10: Status of existing Traffic Density and Vehicle Movement in and around Study Area

Seasons	Heavy Vehicles /hr	Light Vehicles/hr	Two Wheelers/hr	Total /hour
Winter	22	56	115	193
Summer	22	49	71	142
Monsoon	26	54	64	144
Total /hour	**70**	**159**	**250**	**479**

Source: EIA Report (EHEPCL) RS ET Pvt Ltd 2015 160 – 20 - 1280

Present Mammal Survey: Based on the issues discussed above, and recording of only 21 mammalian species with very low abundance (less than one animal/1552 trap nights). After deploying 78 cameras for 1552 trap night/days in four months' survey, no tiger was camera trapped. Thus, tiger presence in the study area was not established. Therefore, low availability of prey species in general and absence of larger prey species in specific, along with human related disturbance in the area, could be the reasons for tiger not using the project area (**Table 5.42 and 5.43**).

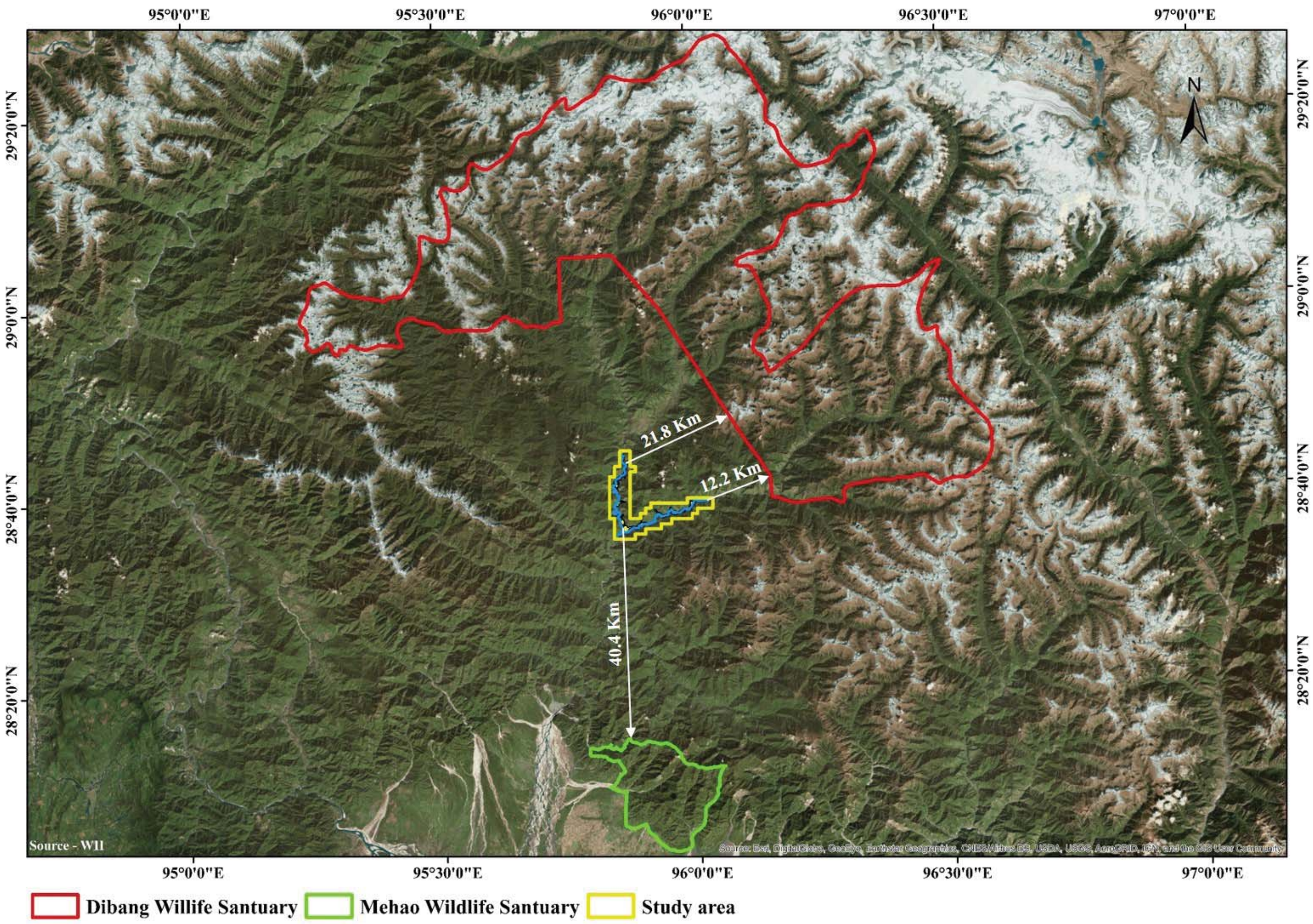
Tiger movement: The long-term monitoring study on mammalian fauna using camera traps in DWLS (October 2015 to July 2016 and November 2016 to June 2017), showed record of few tigers outside the DWLS, especially along the southern boundary. The linear distance measured for the three nearest records (locations) of tigers outside the DWLS and between the boundary of proposed project site ranged from 10.2 km to 14.0 km from the north (tail end of submergence) of the Dri and Tangon reservoir areas respectively (**WII a – Ongoing study) Map 6.6.** Another ongoing camera trap study on mammals in lower Dibang valley in Mehao Wildlife sanctuary, in the last eight months (October 2017 to May 2018) reported presence of 23 species with 22 species being camera trapped and one arboreal mammal *viz.* Eastern Hoolock Gibbon was directly sighted. The 22 camera trapped species does not include tiger, as till date no tiger has been camera trapped (**Table 6.11** - **WII b – On going study**)

Tigers inhabit diverse habitat types, and are distributed even in very high altitudinal range and gradients in this region, they have been camera trapped at an altitude of 3630 m in snow in community forests in Dibang Valley District (**Map 6.7**). It has been reported at a distance of approximately 10 km north from the northern boundary of the EHEP study site. Though the project area is a potential habitat for tigers, this present study did not document the occurence within the project area. The existing cumulative impacts of the above-discussed factors like, presence of villages, road widening and construction, habitat degradation, hunting, high vehicle movements and low prey base may be the reasons for tiger not using the area. Further, considering availability of large extent of suitable habitat in the surrounding environs well above the project area, this hydropower project is not visualized to restrict the movement of tigers occurring in and around the DWLS into any direction in the entire Dibang Valley. In spite of all the above given reasons, considering the importance of conservation, monitoring of tiger distribution and movements need to be continued in Dibang Valley and Lower Dibang Valley districts, in addition to a long-term monitoring project that should be initiated beyond the project area and especially in the eastern and western hill ranges of the project site.

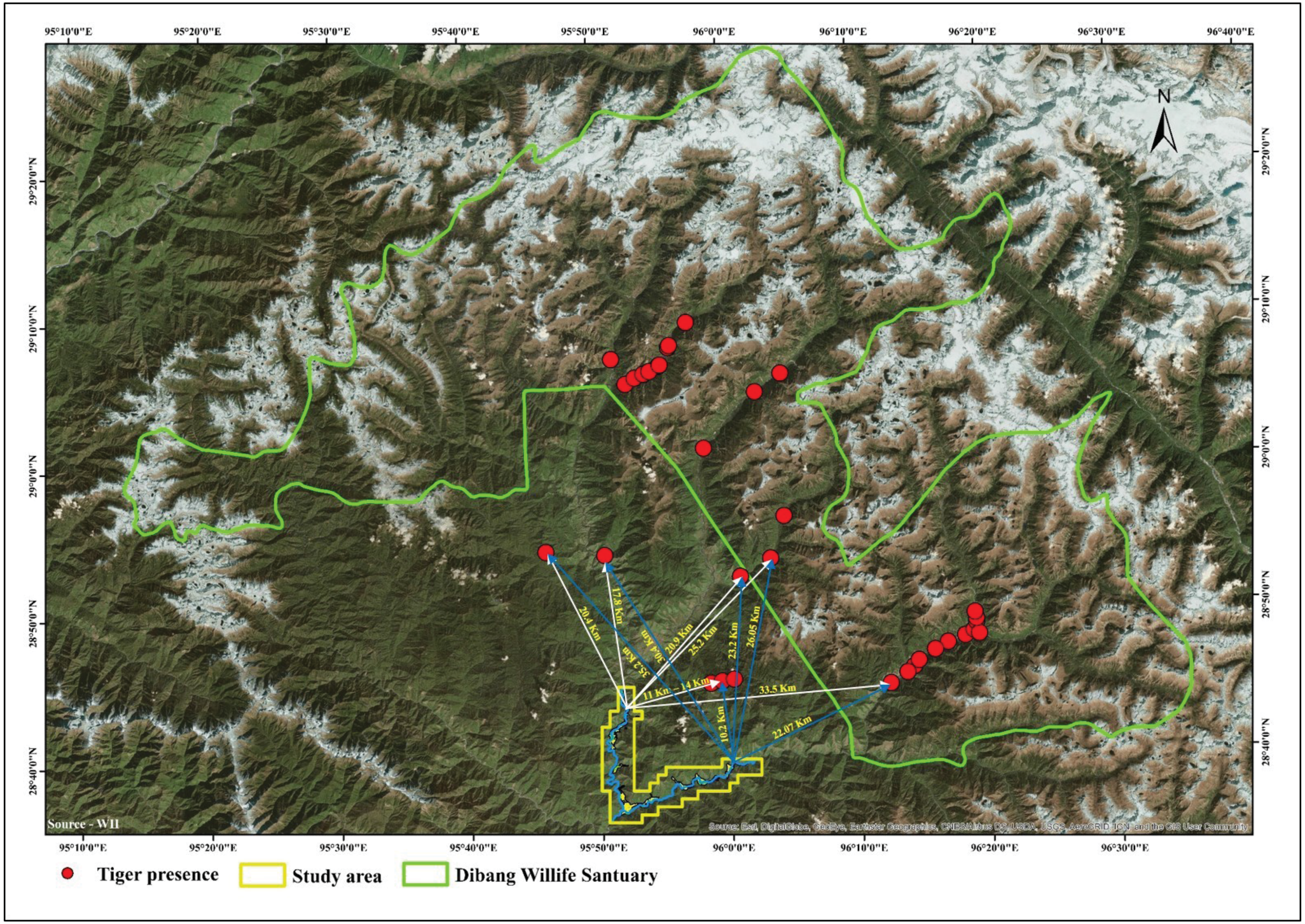
Table 6.11: Checklist of Mammals of Mehao Wildlife Sanctuary, Lower DIbang Valley, Arunachal Pradesh (Source: WII Ongoing Study)

S.No.	Species	Scientific Name	IUCN Status
1	Eastern Hoolock Gibbon **	*Hoolock leuconedys*	Endangered
2	Assam Macaque	*Macaca assamensis*	Near Threatened
3	Indian Muntjac	*Muntiacus muntjac*	Least concern
4	Hog Deer	*Axis porcinus*	Least concern
5	Mishmi Takin	*Budorcas taxicolor*	Vulnerable
6	Himalayan Brown Goral	*Nemorhaedus goral*	Near Threatened
7	Himalyan Serow	*Capricornis thar*	Near Threatened
8	Indain Wild Pig	*Sus scrofa*	Least concern
9	Clouded Leopard	*Neofelis nebulosi*	Vulnerable
10	Asian Golden Cat	*Catapuma temmincki*	Vulnerable
11	Marbled Cat	*Pardofelis marmorata*	Vulnerable
12	Leopard Cat	*Prionailurus bengalensis*	Least concern
13	Spotted Linsang	*Prionodon pardicolor*	Least concern
14	Himalayan Palm Civet	*Paguma larvata*	Least concern
15	Large Indian Civet	*Viverra zibetha*	Vulnerable
16	Wild Dog	*Cuon alpinus*	Endangered
17	Asiatic Black Bear	*Ursus thibetanus*	Vulnerable
18	Yellow Throated Martin	*Martes flavigula*	Least concern
19	Yellow Bellied Weasel	*Mustela kathiah*	Least concern
20	Indain Crested Porcupine	*Hystrix indica*	Least concern
21	Asiatic Brush-Tailed Porcupine	*Atherurus macrourus*	Least concern
22	Palla's Squirrel	*Callosciurus pygerythrus*	Least concern
23	Himalayan Striped Squirrel	*Tamiops macclellandi*	Least concern

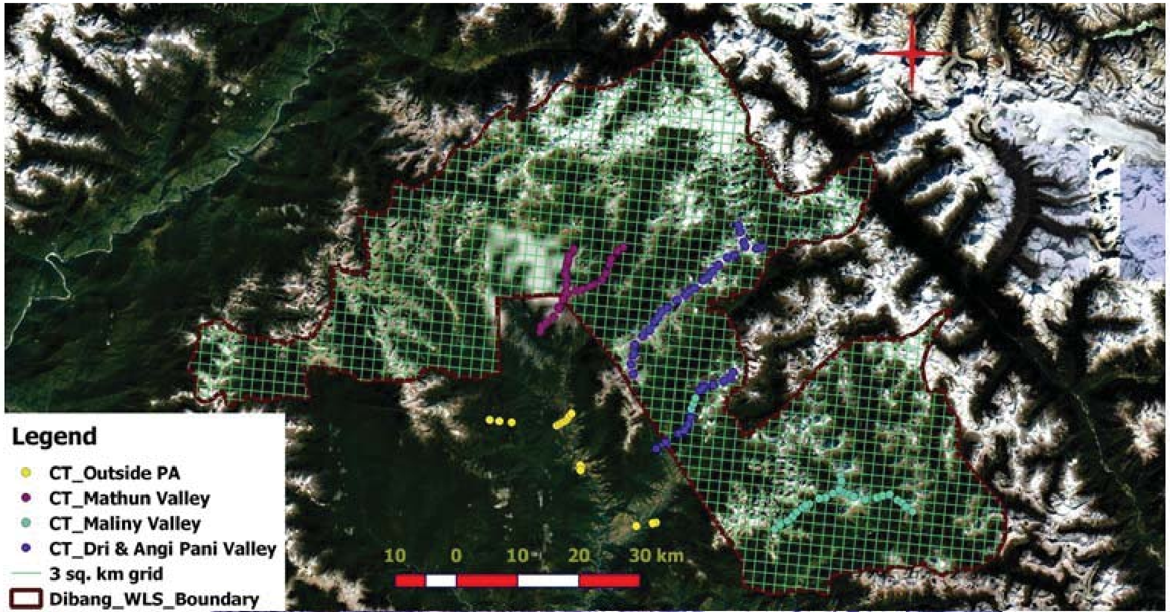
**** species not trapped in the cameras: Source – WII b - ongoing Study**



Map 6.5: Distribution of Ecologically Sensitive Area in the Etalin HEP Study Area Landscape



Map 6.6: Distribution and Possible Movements of Tiger in and around the Etalin HEP Study Area (Source: WII Ongoing Study)



Map 6.7: Tiger Camera Trapped at an altitude of 3630 m outside Dibang WLS in Community Forest (Source: WII Ongoing Study)

CHAPTER 7: Mitigation – Biodiversity and Wildlife Conservation Plan

7.1. INTRODUCTION

"Mitigation Measures," refer to action plans that can be implemented to minimize the magnitude of the project related detrimental impacts on different physical, biological and social environments of the project area. It involves planning and implementing measures to prevent adverse impacts from occurring, and in case this is not possible, to limit their effects to a tolerable level. Different hierarchical approach of mitigation measures are: **Avoiding impacts** by modifying a proposed plan of actions in order to prevent or limit a possible impact, which is highest priority and should always be considered in mitigation; **Minimizing impacts** by implementing decisions or activities that are designed to reduce the undesirable impacts of a proposed activity; **Rectifying impacts** by rehabilitating or restoring the affected environment; and **Compensating** for the impacts by replacing or providing substitute resources or environment, which is a last option and might include so-called offsets (GPG-ICMM 2006).

As part of the proposed Etalin HEP project, in Dibang Valley district of Arunachal Pradesh, the conservation and management plan, however involves considering all the above-mentioned concepts, it also considered the State Biodiversity Conservation Strategy Action plans (SBCSAP) and Biological Diversity Act (2002).

With this understanding and prevailing project environment and biodiversity status, some biological interventions are suggested to take care of both, to minimise the identified impacts and enhance the biodiversity, which is the prime goal of the present study. Therefore, the suggested mitigations fall under the categories of **minimizing**, **rectifying** and **compensating** the impacts. The mitigation measures recommended are broadly grouped in to four sub-categories such as: 1. mitigation to minimise the impact of bio-physical environment – land, water and air, which are likely to have direct or indirect effects of biological and social components on need basis, 2. Biological environment – habitat, flora and fauna, 3. Social environment – natural resource enhancement, livelihood improvement and awareness education to reduce the biotic pressure and, 4. Biodiversity enhancement – species groups / Communities, species and threatened fauna.

7.1.1. General Priorities for Biodiversity and -Wildlife Conservation Plan

The nature of EHEP project and its associated construction and operational phase activities, the findings of the biodiversity status, including the indigenous people and other considerations, are the project contribution to cumulative effects identified, evaluated and discussed in detail in previous chapter on Impact (**Chapter 6**). The major impacts identified are as follows:

1. Land acquisition for project - Loss of habitat.

2. Muck-Dump Generation and Handling – Impacts on bio-physical and biological resources.

3. Dust and gaseous emission- Impact of habitat degradation and decrease of faunal diversity.

4. Drilling and Blasting – Impacts of noise and vibration on selected faunal groups.

5. Roads, heavy vehicle movements – Impacts of animal movements and isolation.

6. Unregulated Vehicle Movement - Road mortality on selected faunal groups

7. Overall Project Construction activities - Impact of aquatic ecosystem

8. Overall Project Construction activities - Impacts on RET Species / Species of Conservation Significance

9. Overall Project Implementation – Impact of biodiversity use values of Local People

10. Influx of Labour Force - Impact on forest resources and Cultural values

11. Project Location - Impacts on ecologically sensitive area

However, suggesting and implementing mitigation measures for all impacts may not be practically feasible. Hence, major impacts have been priorotised and mitigations suggested for implementation.

This conservation plan has been drawn taking the existing scenario into consideration and mainly for the betterment of habitat quality of the forests and other ecosystems in the project areas. The conservation and management plans suggested here are mainly the issues identified during the survey, specific to biodiversity values of both terrestrial and aquatic systems and the local's perception on the effects on biodiversity use values. The following are the major biodiversity conservation issues and management plans suggested.

7.2. PRIORITY ISSUES FOR MITIGATION AND CONSERVATION PLAN

7.2.1. Compensatory Afforestation: Loss of Habitat

Compensatory Afforestation - is the first plan of action and mandatory to mitigate the loss of habitat due to conversion of forest land for the project implementation. However, in most of the cases, the afforestation program is done just like an ordinary plantation with single species are multispecies of exotic and non-local / non-native species, rather than following scientific approach. Therefore, some scientific approaches are suggested under this mitigation plan.

7.2.2. Green Shelterbelt – Phyto-remediation: Impacts of Dust and Gaseous Emission

The impacts on air environment, would indirectly affect the biological values (habitat, flora, fauna) of the project area in terms of habitat degradation. Therefore "**Green Shelter Belt Development – Phyto-remediation",** a biological intervention is suggested for improving the ambient air quality and minimise the impacts of dust and gaseous emission.

7.2.3. Muck-dump Management and Restoration – Terrestrial and Riverine Habitat

Large quantity muck / waste dumps will be generated due to excavation activity for the tunnels and construction of different project structures. The proposed excavation in different location is kind of mining activity, hence need to strictly follow similar management actions prescribed for mining pertaining to muck/waste disposal. Therefore, **Muck/waste dump handing- Technique** is prescribed to avoid impacts associated to dust emission.

7.2.4. Technical and Managerial Interventions - Drilling and Blasting Effects on Selected Faunal Groups

Drilling and blasting for the, construction of HRT, widening and deepening of river beds along the down streams are one of the major supportive activities of the project implementation, that is visualised to have impact on selected faunal groups. Therefore, Technical and Managerial Interventions are suggested to minimise the impacts of noise and ground vibration on ground dwelling fauna groups.

7.2.5. Spatio-temporal Regulatory Mechanism - Roads and Vehicle Impacts on selected Faunal Groups

Heavy vehicles movement, and different types and capacities of heavy equipment will be in use for the construction activities and other project structures. The magnitude of vehicles movements and equipments to be used in terms of numbers and for a longer period of seven years, is predicted to have impact on selected faunal species like – birds, butterflies, herpetofauna and smaller mammals of the project area. Therefore, with understanding of field scenario, mitigation measures are suggested under "**Spatio-temporal Regulatory Mechanism"** to minimise the habitat degradation, and **Technical intervention** – to avoid road mortality.

7.2.6. Species Group Conservation Plan – Habitat / Niche Enhancement or Development.

Among the faunal groups surveyed, butterfly and avifauna, reported high species richness. Therefore, to mitigate all the above impacts related to physical component (habitat loss, degradation and dust and gaseous emission) and their effect on overall faunal diversity, the following species group specific conservation plans are suggested under habitat/niche enhancement / development program.

- Conservation of high species richness of Butterfly groups through the development of open and or closed "**Butterfly Parks"**
- Conservation of high species richness of avifauna through **"Facilitating Nesting Niche"** – deploying nest boxes for the primary and secondary hole and cavity nesting bird species.
- Record of only 31 species of reptiles with low abundance and record of only three RET species / species of conservation significance, based on field and secondary sources, it is recommended to develop open **"Reptile Park - Habitat /Niche"** in an area /site earmarked for solid waste deposal.

7.2.7. Aquatic Ecosystem

Many impacts have been discussed in detail on Impacts on River Habitats - Water Quality and Physical Changes (**Refer section: 6.8.3**) and Impacts on Aquatic Biodiversity (**refer Section 6.8.4**). This being river runoff project, and aquatic ecosystem is highly dynamic and sensitive, maintaining the environmental flow or e- flow during the post construction and operational phase is highly crucial. Therefore, selected mitigation measures are suggested specific to aquatic biodiversity in the form of some technical and managerial implications such as: **Waste Debris Management, Maintain Stream Morphology, Waste Disposal Management – Industrial and Domestic (**by the migrants in the respective appropriate sections.

7.2.8. Habitat Rehabilitation and Restoration – Impact on RET species

Biodiversity status survey of the project area resulted in high species richness of flora, birds, butterfly, moderate level of other entomofauna, herpetofauna and mammal species, and presence of few RET species. However, low abundance status of most of the species and few individuals of threatened species, along with predomination of forest and river habitat and absence of any critical habitat, it was not possible to suggest any threatened species and habitat specific conservation plan.

- Nevertheless, keeping the importance of biodiversity conservation in total and importance of species of conservation significance (RET& endemic species), different representative **Habitat Rehabilitation and Restoration** plans are suggested to enhance the overall habitat quality of the study area so that, the RET species / species of conservation significance of the project study can have benefitted**.**
- **RET – Flora:** High floral diversity was reported in the project area (498 plant species) with only one threatened plant *Piper pedicellatum*, listed as vulnerable species under IUCN (**Table 5.4 & Annexure 5.1**). Being endemic to Arunachal and was found in high density in the study area, no any specific conservation plan is necessitated. However, keeping the floral uniqueness of the Dibang valley; diversity of orchids, threatened and endemic species, pteridophytes and lichens and fungai (**See Box 6.1**), it is recommended to develop a "**Threatened Floral Gene-Pool Plot – TFGPP"** in the close vicinity of the project area.
- **RET species of Herpetofauna, birds and mammals:** The project study area also reported 230 species of birds including five schedule I under IWPA, seven species as near threatened under IUCN red list, and seven species endemic to Arunachal Pradesh (**Table 5.38 & Annexure 5.9**). The 31 species of reptiles included three threatened species of reptiles (**Annexure 5.8**). Further, the project study area reported 21 species of mammals with eight threatened fauna (**Table 5.45**), including the species reported in the Dibang wild life sanctuary the list goes up 42 species with overall of 18 threatened mammals in the close vicinity of the project study area (**Table 5.45 & 5.46**). Due to the low abundance of these faunal groups, and diverse dietary/foraging patterns, habitat requirements and use; species and habitat specific conservation plan is not possible. Therefore, overall the above suggested **Habitat Rehabilitation and Restoration Plans**, **Butterfly Parks, Facilitating Nesting Niche and Reptile Park- Habitat / Niche** are predicted to enhance the abundance status of some of the RET fauna.

7.2.9. Natural Resource and Life Quality Enhancement – Loss of Forest based Natural Resource

The entire local population belong to forest dependent ethnic group and 50% of the project affected people depend on forest resource (NTFP, Hunting, fishing and collection of wood resources) for income generation and survival. Further, the locals also hunt 30 and 43 species of mammals and birds respectively from the forest. Therefore, conversion of community land for the project implementation has been visualised to have natural resource depletion for the forest dependent local villagers and also restrict the access to the forest resources, which need to be addressed.

The number of outside project workers, estimated to influx in the project area. is around 12,000 people (150% increase in existing project area population) and their dependency on forest resources would also create forest-based resource (both NTFP and Wood resources) conflict, in addition to increase in illegal poaching and hunting, which is direct threat to faunal biodiversity and biodiversity use values of the locals that is partly linked with cultural values.

- Implementing "**Natural Resource Enhancement" plans,** would facilitate to cater and improve the resource lost due to depletion and also prevent the re-settled project affected villagers to put pressure in the adjoining / additional forest habitats. The following are some of the resources needed to be developed

1. **Grass and Leaf Fodder Plots for Mithun**
2. **Bamboo Plantation**
3. **Wild edible Plant Garden**

- **Life Quality Enhancement** – is the best way of mitigation. mainly through providing job opportunity in the project activities and self-employment through income generation schemes. This would partly minimize the forest resource dependency.

  1. **Providing job opportunity**
  2. **Create Income generation sources**
  3. **Health Care**
  4. **Improved education facilities**

  Well informed and effective "**Awareness Education Programs**" on biodiversity conservation and ecosystem services needs to provided, for both the locals and migrant populations. The awareness programs would cover the themes: **Sustainable resource use, Hunting of wild animals and Resource depletion and conflicts.**
- Initiate and involve locals in preparation of **Peoples Biodiversity Register,** which would collectively mitigate the hunting pressure, in addition to taking care of issues related to resource conflict.
- Strict enforcement of **Anti-Poaching Mechanism** and monitoring to stop the illegal activities by the migrant, would take care of the resource conflict as well as decrease / curb biodiversity use values of the villagers.
- In addition to the influence of project on natural resource depletion, additional pressure and conflicts on forest resources, cultural values are likely to be impacted due to migrant population. Being a social issue, that needs to be tackled with **Stakeholders Interaction** among the villages, district administration and project proponent level through formation of Village level, **Village Forest Management Committee (VFMC) / Village Natural Resource Management Committee (VNRMC)** and village cluster level **Eco-development Committee (EDC)**.

7.2.10. Research and Monitoring – Ecologically Sensitive Area and Key Species Monitoring

Dibang Valley Wildlife Sanctuary (DWLS) and Mehao Wildlife sanctuary (MWLS) are the two ecologically sensitive areas located nearest to the project area. However, the linear distances estimated are found to be around 12.5 km (DWLS from Study area) and 40.4 km (MWLS from Study area) on the hill ranges in the up and down stream of the project area, respectively (**Map 6.5**).

Movement and migratory route of the key species (mammalian fauna), and specific to tiger was assessed based on the long-term camera trapping study in DWLS, showed the nearest tiger location was 10.3 and 11.0 km north of the project site. Another ongoing study in MWLS, did not establish the presence of tigers in the last eight months camera trapping. The present study also documented that, tiger occurrence in the project area was not confirmed, mainly due to the existing biotic pressures and low prey base **(Refer: Section 6.11.2**).

In spite of all the above given reasons, considering the importance of conservation, **monitoring of tiger distribution and movements** need to be continued in upper and lower Dibang Valley, in addition to a long-term monitoring project that should be initiated beyond the project area and especially in the eastern and western hill ranges of the project site.

7.3. ACTION PLAN – MITIGATION AND CONSERVATION PLAN

The previous sections discussed diverse mitigation and conservation plans based on the issues identified during this present study and rationale for the implementation of the suggested plans. Further these plans can be grouped into three types such as, 1 **Mitigation plans – Mandatory, 2 Conservation Plans – Biodiversity enhancement** and **3. Conservation plan – Biodiversity and Resource enhancement of Peoples' use values**. The mitigation plans are mandatory under the MOEF&CC to avoid and minimize the impacts identified on bio-physical component, which would indirectly influence the biodiversity attributes of the study area and is already incorporated in the EIA & EMP plan. However, some of the plans suggested here are biological interventions for improving the project environment. While the second level of conservation plans are very important and focused mainly on the direct impacts on biodiversity of project area and to enhance the biodiversity at species group, species specific and social use value levels. The third level of conservation plans is to address the loss of natural resources on which the ecosystem people (local ethnic group) depend, and resource depletion due to project implementation and migrant people related to the project (**Table 7.1.).**

Table 7.1. Categorization of the Mitigations and Conservation Plans

RECOMMENDED MITIGATION AND CONSERVATION PLANS	PLAN OF ACTIONS
I. MITIGATION PLANS	1. Compensatory afforestation 2. Green shelterbelt- Phyto remediation – Dust and Gaseous emission 3. Muck-dump management and Restoration 4. Technical and Managerial Interventions – Noise and Vibration 5. Technical and Regulatory Mechanism **–** Road Mortality of wildlife
II. CONSERVATION PLANS – BIODIVERSITY	6. Species Group conservation plan – Habitat/ Niche development. 6.1 Butterfly Parks 6.2. Reptile Park – Habitat / Niche 6.3. Facilitating & Enhancing Nesting Niche 7. Habitat Rehabilitation and Restoration –RET Species 8. Threatened Floral Conservation Plot– TFCP

RECOMMENDED MITIGATION AND CONSERVATION PLANS	PLAN OF ACTIONS
	Action Plans: 6.1, 6.2, 9. Aquatic Habitat and Biodiversity – Mitigation and biodiversity
III. CONSERVATION PLANS – BIODIVERSITY & RESOURCE OF PEOPLES' USE VALUES	10. Natural resource and life quality enhancement 10.1. Grass and leaf fodder plots for Mithun 10.2. Bamboo plantation 10.3. Wild edible plant garden **Life Quality Enhancement** 10.4. Providing job opportunities 10.5. Create Income generation sources /options 10.6. Health Care 10.7. Improved education facilities 10.8. Encourage sports and games **11. Awareness Education Programs** 11.1 People biodiversity Register 11.2. Sustainable Resource Use 11.3. Regulation on Hunting of Wild animals **12. Anti-poaching Mechanism** **13. Stakeholders Interaction – Cultural Values** **14. ESA- Research and Monitoring**

7.4. MITIGATION – MANDATORY ACTION PLAN

7.4.1. Compensatory Afforestation

Compensatory afforestation is one of the foremost mitigatory measures that comes under the compliance of MOEF & CC to address the loss of habitat and associated biodiversity. In general, the area identified for the afforestation program need to be in the close vicinity of the project area. However, in some cases, due to non-availability of site and needed extent of area, the afforestation program is shifted to far-off sites from the project area. Added, most of times the afforestation is done with single species (mono culture) or planting of fast-growing exotic species, which is against the concept of biodiversity conservation, the prime objective of the present study. Therefore, under these heads the following suggestions are made for the afforestation program (**Table 7.2**). The total budget required for Compensatory Afforestation is Rs. 67,50,000/- for five years, the break for which is detailed in **Table 7.23**.

Table 7.2: Compensatory Afforestation – Mitigation to Loss of Habitat and Associated Biodiversity

Mitigation Theme	Action Plan
Compensation to Habitat Loss	1. *Select the diverse native plant species of different habits (tree, shrub, woody creepers, grass and herbs) for plantation.* 2. *Strictly avoid monoculture and exotic species.* 3. *High preference should be given for planting the 13 trees, 14 shrub and 18 climber species suggested under afforestation program (**Annexure 7.1**).*
Compensate the decrease in biodiversity	4. *Since the suggested 13 tree and 14 shrub species are native and secured high IVI and PVI values, they are the ecologically potential / promising species that would provide high survival rate if all the pre-planting land preparations and planting are well taken care*
Additional habitat for species colonization	5. *Best practice is to collect seeds of all these possible wild tree, shrub and stragglers species involving local villagers – local tribes those who are familiar with these species and also engage them to develop nurseries (at least one each along Dri and Tangon), owned by project proponent, for all the plantation activities owned* 6. *The top soil management is one of the important aspects, and first step in habitat restoration activities. Therefore, top soil from all the areas identified for the construction of different structures and for different project related activities, should be taken / removed and managed in proper manner* 7. *Where ever possible transfer topsoil from areas being stripped, immediately to areas being reclaimed rather than to long term topsoil storage locations (this will help ensure survival of soil seed bank and aid reclamation- Hall et al 2009).* 8. *Using the top soil during land preparation can be excellent source of seed bank of native herb and grass species. Therefore, no special effort needed for growing grass and herb species.* 9. *In addition, few more tree and shrub species of the local forest habitat can be supplemented to increase the floral diversity in, the afforestation program.* 10. *All the technical aspects of land preparation, planting, after care, and management need to be carried out with the well experienced (at least 10 years) forestry expert with two field taxonomist / biologists.* 11. *In case the compensatory if afforestation program is shifted to far-off site / place from the project area, in addition to following the above suggestions, it is very important to carry out floral survey in the nearby forest habitat to selected and identify the dominant tree, shrub and woody creeper species to give preference for including these local plant species in the plantation list.*

7.4.2. Green Shelterbelt- Phyto-remediation

All the project related land preparation, excavation, construction, handling of waste dump, man power and material transportation, movements of vehicles and underground tunnelling are the major source of dust and gaseous emission (**ref Section 6.6.1, Chapter 6**). Many scientific studies have proved that, plant species can act as bio-filter agent to control air related pollution problems at population and species levels (Mansfield, 1976, Sanders 1976, Garsad and Rutter 1982, Scholz, 1981). The species morphology (tree size and shape, leaf structures and foliage area) influence the controlling of accumulation of dust and gaseous emissions (Martin and Barber 1971, Das 1981, Giridhar and Chaphekar 1983 and Chaphekar 1994). Therefore, with the understanding of the magnitude of air pollution that is likely to occur and the role of plant species as bio-filter agent, it is recommended to develop biological intervention: - **Green Shelterbelt- Phyto-remediation (Table 7.3),** in addition to general technical options in practice. The total budget need for **Green Shelterbelt – Phyto-remediation** is Rs. **12,00,000** /- the details of which are given in **Table 7.23.**

Table 7.3: Green Shelterbelt – Phyto-remediation – Mitigation for Dust and Gaseous Emission, Habitat degradation and Biodiversity Loss

Mitigation theme	Action Plan
Minimise air pollution Maintenance of air quality *Habitat for faunal species* *Climate Régulation*	**Species Recommended** 1. *Based the review of literature Central pollution control board (CPCB) identified many plant species to mitigate the air pollution (dust and Gaseous emission) related to different development project activities. From the CPCB list a total of 47 tree species have been selected, they were reported from the study area and suggested for the development of Green Shelter Belt (GSB) under Phyto-remediation to mitigate the air pollution due project construction activities* 2. *Among the list, 23 species have been directly selected and recommended, since they have been listed in the CPCB list. The CPCB list includes predominately species of lower altitude and focused to address the pollution issue in and around the urban and industrial area. Hence, the choices of selection of more species were limited. Therefore, in order to diversify the species selection, some of the species come under the genus of CPCB suggested list were also included and resulted addition of 24 species (CPCB-2000- PROBES/75/1999-2000).* 3. *Among the seven ficus species reported in the study area only Ficus roxburghii and Ficus semicordata were matched with total eight ficus species suggested by CPCB to control the dust emission. Considering pollutant tolerance efficiency of the genus ficus, rest of five species reported in the study area (Ficus cuneata, Ficus cyrtophylla, Ficus heterophylla, Ficus hookeriana and Ficus lacor) were also included the final list.* 4. *Genus ficus being food sources of many frugivore birds and some threatened mammals like Arunachal Macaque and Himalayan Black Bear and other species Indian wild pig,*

	*Himalayan palm civet and possibly four species squirrels, giving preference is very important to support these dependent species (**Table 5.39**).* 5. *Similarly, four species of Bamboos and three species of Pines were also added in the list to improve the dust capturing efficiency of GSB in the study area (**Annexure 7.2**)* **Planting Locations** 1. *The project area being dominated by undulating terrain, availability of space along the road side is very limited. Therefore. develop the green shelter belt giving first preference to the roads cutting across the villages, school, proposed office premises, labour colony and Health Centre etc.* 2. *After construction of the new roads and widening of the existing roads, wherever adequate space is available need to be planted those selected species immediately.* 3. *Green shelter belt should also be developed around the periphery of the all kind of waste dumping sites.* 4. *Recommended to plant two rows of GSB following staggered techniques all the areas of Habitations while single row along the road sides.*

7.4.3. Muck-dump management and Restoration

The total quantity of muck to be generated due to excavation and underground tunnel construction etc is estimated to be 165.65 Lac m^3. This net quantity of muck is to be disposed into 12 muck dumping yards. This works out to be 117.35 Lac m^3 and require land area of 113.70 Ha. Dust emission during muck handling, dump formation, runoff muck due to soil erosion, predominately impact on hydrological regime and water quality of both the Dri and Tangon rivers. Hence adopting some technical and biological (dump restoration) mitigations would curtail the possible impacts on aquatic ecosystem (**Ref Section 6.5.1.- Chapter 6 and Table 7.4**). The estimated cost for **Muck Dump Management and Restoration** is Rs. **33,00,000** /-, the breakup of which are given in **Table 7.23**.

Table 7.4: Muck-dump Management and Restoration to Minimise the Impact on River Systems

Mitigation Theme	Action Plan
Minimise impact – aquatic ecosystem Additional Habitat created – muck-dump restoration	**Technical aspects** 1. *Though 12 sites were identified for muck-dump disposal, proper care must be taken that, the dumps should not disturb the flow of small streams into the rivers.* 2. *Avoid setting up / formation of dump close to the river banks.* 3. *In case it isf not possible, a footwall must be developed / provided at the bottom of the external dump, to render stability to the dump and stop rain-wash runoff into the river system. The footwall must be provided with weep holes.* 4. *Design dump dimensions (height and slope) to facilitate vegetation re-establishment, control sheet runoff and erosion, facilitate lateral and vertical wildlife movement, and to avoid unnecessary loss of adjacent vegetation.*

	5. *Muck dumps and backfill areas will be formed in lifts, each dump should not exceed a maximum height of 10-15m and a maximum slope angle must be <30°.*
	Restoration Techniques
Enhance all the faunal biodiversity	6. *Once the dump formation has been completed, the horizontal portions, i.e., top of dump and terraces will be levelled and scarified to reduce compaction and allow for effective revegetation. Once the dozing & levelling process has been completed a layer of topsoil will be spread over the levelled area. The depth of topsoil spread over the site will be maximized based on the amount available and area to be covered. 15 cm is a recommended minimum for grass establishment.*
May provide habitat for some RET species	7. *Collect seed of the native grass species reported from the study area and make grass pellets mixing with native soil and farmyard manure with water and sow the grass pellets on the dumps, just before the onset of monsoon.*
	8. *Planting of shrub on dump slopes will be done using native shrubs (**Annexure 7.1**) randomly in 10-15 m radius patches with 3-4 shrub patches/ha area, with 10 species per patch. In between shrub patches plant some fruiting tree species (**Annexure 7.6**) as well as more native species (**Annexure 7.7**) to create a more biodiversity friendly habitat. Greater emphasis could be given to faster growing native tree and shrub species for immediate stabilization.*
	9. *Development of shrub patches and tree planting need to be initiated just before the onset of monsoon to increase survival rate.*

7.4.4. Technical and Managerial Interventions – Noise and Vibration

Increase in movements of vehicles, machineries, workshops, operation of DG sets, drilling and blasting for tunnelling and quarrying are the major sources of noise and ground vibration. Though pre-project noise level showed to be within the limit of noise level for industrial and commercial area, the project area being / falling within the forest habitat and village area, the observed limits showed that it is on higher side for residential (rural) and forest (silence zone), during both day and night hours (**Ref Section 6.2.2 – Chapter 6**). Therefore, implementing the following technical and managerial skills would minimise the impacts of noise and ground vibration on selected faunal groups (**Table 7.5**).

Table 7.5. Technical and Managerial Interventions to minimise Noise and Vibration Impact on selected Faunal Groups

Mitigation theme	Action Plan
Minimise noise and ground vibration Day activity pattern and movement patterns of faunal	1. *Standard Mine Explosives (SME) in terms of measures should be in practice to ensure controlled blasting – quarry activity.* 2. *The suggested number of rows in a blast, must not be more than four to reduce fly rock and ground vibrations.* 3. *Attempts must be made to have one large blast with less frequency than to have several small blasts.*

species maintained Minimise Local disappearance of faunal groups	*4. Muffling of holes including the area to be blasted must be done* *5. All the heavy equipments in use must be provided with silencers and ergonomically designed air-conditioned cabins to the extent possible to reduce the noise exposure levels.* *6. Proper maintenance of machinery and transport vehicles is must to reduce the noise and keep the same within reasonable limits.* *7. PU panels shall be used in vibrating screens to minimize noise generation – quarry areas.* *8. Regulate the blasting activities during the day hours – twice in a day, - mid-forenoon and mid-afternoon* *9. Strictly avoid blasting during the night hours* *10. Conduct periodic noise level measurements in the quarry and blasting area once in every six months* *11. Possibly tree plantation / green belt development programme can be used as barriers for minimizing noise propagation, provided space availability. The list of plant species suggested can be used in plantation (**Annexure 7.2**).* *12. Possibly all the quarry pits should be re-filled and restored and vegetated.*

7.4.5. Technical and Regulatory Mechanism- Mitigation for Faunal Mortality

Construction activities involve heavy vehicle traffics as well as movement of equipments. The intensity and speed of vehicles specifically carrying manpower - materials are likely to be more compared to the movement of equipments. Therefore, following the on ground technical implication and regulatory mechanisms to restrict the speed and frequency of movement, would minimize the impacts on herpetofauna and ground dwelling mammals (**Ref Section 6.71 & Chapter 6 and Table 7.6.**). The estimated budget for the implementation of this action is Rs. **19,00,000** /- (**Table 7.23**).

Table 7.6. Implementing Technical and Regulatory Mechanism to avoid Road Mortality of selected Faunal Groups

Mitigation Theme	Action Plan
Population isolation minimised **Reduces the rate of road mortality (herpetofauna and small mammals)**	*1. Roadside trenches all along the roads to be newly constructed / developed for 50 km stretch.* *2. Connect these trenches through two, 1m diameter strong pipe at every 1 km intervals. These will act as under passes that would facilitate the amphibians, reptiles and small mammals to cross the roads.* *3. Possibly construct RCC culverts of 2m height and width (the culverts size may vary depending on the dimension of the stream), wherever streams are crossing the roads. These also will act as under passes that would facilitate, amphibians, reptiles and small mammals to cross the roads.* *4. Erect sign boards at regular intervals to control the speed limits and also at regular / frequent animal crossing points along the road planned for different project-based activities.* *5. Educate the drivers to maintain the speed limits and restrictions on blowing horns, while driving through the forest habitats to prevent bird collision and animal road mortality. Drivers should also be instructed that Right of Way is for the animals, so must stop and allow them to cross.*

7.5 CONSERVATION PLAN – BIODIVERSITY

7.5.1. Species Group Conservation plan – Habitat / Niche Development / Enhancement

The project study area reported high species richness of butterfly, birds and moderate richness of herpetofauna, however, due to low abundance status three types of conservation plans are suggested for butterfly species, specific group of hole / cavity nesting birds and reptile species. The details of plan of actions for these are discussed in the following sections.

7.5.1.1. Development of Open Butterfly Parks

Table 7.7: Species Group Conservation – Development of Open Butterfly Parks

Conservation Theme	Action Plan
Additional habitat for butterfly species **Enhancement of butterfly diversity** **Butterfly park can be recreational for local kids, students and public**	1. *Some of project areas like residential colony, labour camp site, office premises, schools and health care centre can be selected for the development of open butterfly parks.* 2. *Therefore, a total 4-5 such open butterfly parks can be developed to attract a portion of the 159 species of butterfly identified during biodiversity surveys.* 3. *It is proposed to grow two types of host plants, food / nectar plants for adults and larval host plants for laying eggs and larval development in the surrounding areas of the above sites. In addition to host plants the area should also develop other ornamental and garden species.* 4. *Based on the field observation and literature, a total of 23 adult host plants and 13 larval host plants have been identified (**Annexure 7.3 & 7.4**), for the development of butterfly parks.* 5. *In these parks, signage for the most common species as well as the threatened species depicting basic information on size, life cycle, distribution and ecological importance of butterflies are to be placed.* 6. *This park could serve as a valuable learning centre for students, the general public as well as interested professionals.* The estimated cost of the five butterfly parks is Rs. **1,30,00,000**/-, the break up of which is given in **Table 7.23.**

7.5.1.2. Reptile Park Habitat / Niche

Table 7.8. Development of Reptile Park/Niche- Facilitating / Enhancement of Microhabitat for Reptile Species

Conservation Theme	Experimental Action Plan
Additional Microhabitats created ***Conservation of reptiles***	1. *Creation of a "Reptile Park / Niche as part of the wildlife conservation plan would make a significant and more conspicuous contribution to herpetofaunal conservation. Two such parks with an area of 5 ha each (one in each Rive limb) would be adequate for this demonstration project.* 2. *The area selected/identified will be free and far from the human habitation (this could be area marked for waste dumps). Artificial burrows in varying sizes will be constructed using rock heaps and propagated with the seeds of local shrubs and grass species.*

Awareness education – safe handling and saving of snake species	3. *A portion of waste wood generated during land clearing will be strategically incorporated within this area.* 4. *Waste rocks and boulders generated during the excavation will be separately dumped in the semi open area as rock heaps close to water sources and partly covered with waste soil/dump materials. 5 to 10 such rock heaps will be developed within the designated area.* 5. *A walk-way will be developed through the area along with a perimeter fence to reduce trespassing.* 6. *Snake awareness program should be undertaken to create awareness of the ecological role of snakes and how to avoid and or safely handle them when they are encountered within the human habitation* The estimated cost of the two Reptile parks is Rs. **48,56,000**/-, the breakup of which is given in **Table 7.23**.

7.5.1.3. Facilitating / Enhancing Nesting Niche

Table 7.9. Facilitating Nesting niche- Deploying Nest boxes for Hole / Cavity Nesting Avifauna

Conservation Theme	Action Plan
Provide additional nesting habitat and compensate for loss of tree with cavities – habitat loss ***Conservation of specific group of avifauna*** ***Knowledge creation on ecosystem services of bird community***	1. *Provisioning the nest boxes for hole and cavity nesting birds is an emerging and interesting conservation plan for avifauna community which would facilitate part of 230 avifauna reported during the biodiversity study from the study area, which included 32-hole nesting species.* 2. *Installing different size nest boxes based on the size of birds would provide hole nesters, additional nesting habitat and space for breeding and nesting* 3. *It is suggested initially to select two locations to install nest boxes in the forest patches around the staff colony and office premises. Each location can be installed with 200 such nest boxes (total 400 Boxes).* 4. *Nest boxes should be set up either before the breeding season sets in for birds, such that the birds have enough time to acclimatize and habituate themselves with the changes in the habitat and alternatives provided.* 5. *The list of cavity / hole nesting birds of the study area and the size of boxes that needs to be made and provisioned are given in **Annexure 7.5**.* 6. *This nest box provisioning programme need to be monitored with the subject expert for two breeding seasons and based on the success rate (nest box occupancy rate), the same can be replicated in other areas.* **7.** *The locals do involve in bird hunting, it is very important to conduct awareness program for the locals, migrant population to create awareness of the ecological role of birds and not to hunt and disturb the nest boxes.* The estimated cost of the Facilitating Nest Niche Project is Rs. **26,57,000**/-, the breakup of which is given in **Table 7.23**.

7.5.2. Habitat Rehabilitation and Restoration –Overall Biodiversity and possibly RET Species

The above suggested habitat restoration plan is focused to conserve overall biodiversity values of the project area and through that some of the RET species can benefit. The compensatory afforestation, will be implemented either in the close vicinity of the project area OR in some other place identified far off from the project site. Therefore, this habitat restoration program is targeted to restore the land areas of Muck dumps (91.79 ha), quarry pits (62.12ha) and 16 ha of labour camps area stated to be restored after construction phase. All the restoration plan and techniques are detailed in **table 7.10.** The estimated cost for the **Habitat Rehabilitation and Restoration – Overall Biodiversity and RET Species is Rs. 50,25,000/-,** the details of which are given in **table 7.23.**

Table 7.10. Habitat Rehabilitation and Restoration – Conservation of overall species diversity and some RET Species

Conservation Theme	Action Plan
Restoration lead to gain of small extent of habitat lost Improved habitat quality – food resources for frugivore birds and mammals and some threatened species Threatened Arunachal Macaque and Himalayan Black Bear may get benefit Enhance the species richness of all faunal groups	1. *It is suggested to restore some of the selected post construction phase project land use area of 168.91ha (muck dumps 91.79 ha, quarry pits 61.12ha and labour camp area 16.0 ha) to minimize the impact of project on overall biodiversity values and possibly some of the threatened fauna.* 2. *These areas need to be restored by planting 58 species of fruiting tree being food resources for frugivore birds and some mammal species (**Annexure 7.6).*** 3. *In addition to some of the 14% of frugivore birds, some of the 59.8% of the insectivore species are likely to get additional habitat.* 4. *The list includes seven species of Ficus, that provides habitat and food to some mammals like squirrels, civets and threatened species like Arunachal Macaque and even Himalayan Black Bear, which **prefer figs and also many other fleshy fruits** (**Annexure 7.6)** So the plantation of native Ficus species at regular frequency will be good for overall habitat quality.* 5. *Some of the other native tree species suggested can also be included in restoration and plantation (**Annexure 7.7**)* 6. *Whenever, the quarry pits get exhausted and muck dumps saturated, they should be restored immediately and not delaying until exhausting/completion of all the quarries and dumps formation.* 7. *The restoration and planting procedures should follow the suggestion given in **Table 7.3** (Green-belt development) and **Table 7.4** (Muck-dump restoration), with the engagement of Mine dump /Forest restoration expert of not less than 10 years of subject experience.* 8. *The local tribes and plant taxonomist should be in the restoration team to identify and collect seeds/cuttings/saplings of the suggested plant species.*
In addition some of the threatened butterfly and herpetofauna may use the butterfly park and reptile habitat developed under Species Group Conservation respectively (section 7.5.1.1 and 7.5.1.2)	

7.5.3. Conservation of – RET Flora

The floral species richness is very high in Dibang valley and it supports diverse and unique species like orchids, pteridophytes, lichens and fungai, in addition to some highly threatened (Critically endangered and endangered) and endemic species to Arunachal (**See Box 6.1**). Therefore, under the concept of conservation of RET flora it is suggested to develop **Threatened Floral Conservation Plot – TFCP** through creating Botanical Garden in the vicinity of the project area (**Table 7.11**). Development of eco-park or biodiversity preservation plot is one of the biodiversity conservation concepts implemented / taken up in many states. The total estimated cost for implementing this specific action on **Threatened Floral Conservation Plot (TFCP)** is **Rs. 29,40,000/-,** the details of which are given in **Table 7.23.**

7.11. Conservation of RET Flora - Threatened Floral Conservation Plot (TFCP)

Conservation theme	Action Plan
Conservation of RET species **Threatened Gene pool restored** **Eco-tourism support**	1. *A site of 5.0ha of comparatively less disturbed / partially degarded forest patch need to be identified, which will have used to develop threatened local native plant species plot.* 2. *It is suggested to carryout intensive survey in and around project area and collect some of the unique floral species (Orchids, lichens, and Pteridophytes) reported in the area (**Annexure 7.8**) to propagate within the TFCP.* 3. *The plant list suggested includes --- species of orchids, 33 species of Pteridophytes and --- species of lichens and therefore preferably maximize the list of species incorporated in the TFCP to make it as best practice* 4. *This conservation plan will be implemented in colobration with the State Forest Department to procure the forest plot as well as for survey and sustainable and appropriate means/ways of collection of species samples.* 5. *The survey and development of TFCP will be implemented with help of subject specialist (person with the knowledge on orchids and Pteridophytes) experience in developing botanical garden* 6. *The plot should be fenced and protected from human disturbance and provided with walk-way and signage describing information on basic ecology and conservation status and importance of the conservation significant species. This can be a part of eco-tourism development.*

7.6. Aquatic Habitat and Biodiversity Conservation

7.6.1. Waste Debris Management System – Habitat Quality

The proposed construction of 50km new approach roads and 35km widening of existing roads is visualized to have impact on both the forest and riverine habitats in terms of loss of habitat and sediment deposition on river system respectively, and thereby indirectly affecting the faunal diversity of both. During the biodiversity survey, the ongoing road widening project along the stretch between Etalin and Yuron village witnessed very high road debris dumped on the river side, that had resulted in total loss of forest cover (**Plate 7.1**). Loss of forest habitat all along the 50 km road stretch is predicted as very high significant impact on both the forest and river systems. Therefore, to minimize such severe impact on the forest vegetation and as well as sedimentation in the river, the following possible **Road Waste Debris Management Actions** are suggested (**Table 7.12**). The estimated total cost for implementing this action which is very crucial is Rs.**1,03,00,000** /-, the break of which are given in **Table 7.23**.

Plate 7.1: Disturbance Forest and Riverine Habitats due Road cutting and widening

Table 7.12. Possible Road Waste Debris management – reduce Forest Loss and Impact on River

Mitigation theme	Actions
Restore and minimize loss of forest habitat **Reduce the impact on**	1. *Survey the entire stretch of the proposed construction of the new roads and road widening* 2. *Identify areas having gentle, moderate and steep slope stretches on the river side slope and earmark for to dump road waste debris. Such areas can be available before and after the village areas.* 3. *Possibly dump the waste debris generated on all those three slope category areas.* 4. *Generally, the chances of availability of gentle slope areas is very rare, however in those area the dump can be spread till the edge of the river to make use of more debris and providing toe wall along the river edge to prevent the erosion.* 5. *Both the gentle and medium slope areas should be terraced as*

aquatic environment	*shown in the **Plate 7.2**, and restore the slope following the procedures suggested in **Table 7.3** (Green-belt development) and **Table 7.4** (Muck-dump restoration)* 6. *Wherever possible the moderately-steep slope area can be applied **coir - mat technique** (**Plate 7.3**) to restore and thereby recover possible extant of habitats lost in road construction activity and significantly reduce the magnitude of impacts on river ecology and associated biodiversity.* 7. *Whenever, considerable length of roads constructed and widened completed, the restoration can be initiated immediately and not to wait for the completion of the entire length of the road. Timely restored area will start regenerate and minimise the rain washed runoff debris into the river system.* 8. *Use list of plants suggested for Muck-Dump restoration plan listed in **Annexure 7.6 and 7.7***

Plate 7.2: Example of Terracing of different slope category dumps

Medium Slope Terracing

Moderate-Steep Slope Terracing

Plate 7.3: Visuals of Use/Installation of Coir-mat to Restore moderate to steep slopes especially along the Road Sides

7.6.2 Maintain the Stream Morphology

The network of both the rivers identified 16 major steams feeding water from the catchment area into the river system. Road cuttings across those streams may cause lot of change in the channel morphology, which may destroy spawning ground and obstruct migratory route of the fishes. Therefore, maintaining the stream morphology to mitigate the impact on stream migration of fish fauna is very important because the upstream migration is already stopped due to the construction of Dams across both the Dri and Tangon rivers. To prevent the impact of road-cutting through the construction of culverts/small dams across all the streams cutting across by the proposed road is a effective mitigation plan **Table 7.13.** The implementation and cost of this action should be included along with the road construction work.

Table 7.13. Prevention of Road-cutting impact on Fish Migration

Mitigation Theme	Action plan
Restore the stream morphology **Mitigate road-cutting impact** **Ensure free migration of fish fauna**	1. *Identification of the major streams out of 16 stream (anon pani, ayo pani, shu pani, achali basti nala, makhri pani, chambo pani, noh nala, mayo pani, kabo pani, ru pani, emi pani, ayu pani, aha pani, aru pani, ayo pani, illi pani) existing in the study area likely to be cutting across by the proposed road* 2. *Suggested to construct culverts or small dam across those streams in adequate size / and or proportionate to stream width without disturbing the stream morphology* 3. *The following care should be given while constructing the culvert or bridges* 4. *Debris excavated on both the sides of the stream to construct concrete structure should not be dumped into the stream system* **5.** *The existing pebbles and boulders should not be removed from the stream bottom – which would disturb the micro habitat of stream and bathymetry which is the potential spawning habitat for many fish and benthic insects.*

7.6.3. Impacts of Hazardous and Domestic Waste Disposal – River System

Hazardous waste and both domestic sewage and solid waste disposal and their impact on project is very common in any mega developmental project. In general, domestic sewage problems will be attended through construction of ETPs, while rest of the hazardous and solid waste require proper management especially in the project area located in the mid of forest and riverine habitat which are discussed below (**Table 7.14**). This action needs to be attended while construction the labour camps and colony.

Table 7.14. Additional Care in Handling Hazardous and Domestic Waste – Plan for Forest and Riverine Habitat

Mitigation Theme	Action
Biological intervention implemented **Adopt Gree Waste Mmanagement Syatem** **Minimise aquatic pollution** **Ensure clean working environment**	1. *Select the waste disposal area of Hazardous and domestic waste far from the river, forest and human habitation and preferable flat area to avoid rain washed runoff* 2. *The area of source of hazardous waste and garbage site should be fenced* 3. *Possibly around the fenced area develop* ***green –shelter belt*** *to prevent the dispersal of toxic odder come from the disposal site (Annexure* ***7.2****)* 4. *The site of hazardous waste should be provided* ***Garland Drainage and connected to filter soke pit*** *so that the wastes disperse into river system stopped.* 5. *These facilitations would prevent the land and river pollution soil and make all the waste disposal system become pollution free.* **6.** *All the Hazardous waste collected periodically and transported to the designated hazardous waste disposal site of State and CPCB* 7. *Biodegradable Domestic waste can be converted into compost and used for restoration propose* 8. *Labours contractors and labours should be strictly warned for proper handling of waste.* **9.** *Educate and encourage the project people on Green-waste management through award system.*

7.7. CONSERVATION – PEOPLE'S BIODIVERSITY USE VALUES

The local villagers being tribal community depend on diverse forest based natural resource for their livelihood and life supporting systems. The social survey on impacts of project on natural resource showed that fodder and wild edible plant are expected to be impacted at low level, while bamboo collection at moderate level (**Table 6.9**). However, during construction period, the migrant work force is visualised to increase the impact levels from low to medium and from medium to high and also create local resource depletion. Hence under natural resource enhancement, it is recommended to develop **Grass Fodder Plot (cost Rs.** 1,00,00,000**/-), Bamboo Plantation (Rs.** 70,00,000**/-), and Wild Edible Plant Garden (cost Rs,** 35,00,000**/-)** (**Tables 7.15 & 7.23**) to minimize local resource loss and depletion.

7.7.1. Selected Natural Resource Enhancement

Table 7.15: Selected Natural Resource Enhancement- Grass Fodder, Bamboo and Wild Edible Plants

Conservation Theme – Biodiversity Use Values	Action Plan
Secured grass fodder resource **Minimize grazing pressure – additional forest area** **Enhanced selected and important natural resources**	**a. Grass Fodder Plot** 1. *The impact on grazing land is problem for the affected villagers, and some of them have to be re-located and therefore that group of villagers need to be consulted for livestock population (Mithun) and requirement of grass fodder.* 2. *Identification of palatable and highly nutritive and locally available grass species will be done with the help of the villagers.* 3. *Collect seeds of the selected grass species and also reported from the study area (**Appendix 1, Table A1-3**) and make grass pellets mixing with native soil and farmyard manure with water and sow the grass pellets on the dumps just before the onset of monsoon.* ***b. Bamboo Plantation*** *4. The project area is known for diverse bamboo species, hence in consultation with the affected villagers the type of species utilized maximum by the locals and also important species used in making different kinds of mats, caps, baskets, utensils and for craft works, need to be recorded,* *5. Since village based bamboo plantation were observed during the biodiversity survey, **a**ll the techniques needed for the development of bamboo plantation will be taken care by the villagers* ***c. Wild Edible Plants Garden*** *6. The villagers use 19 species of edible plants collected from the nearby forest habitat and use different plant parts, which form as part of food resources (**Table 5.53**)* *7. Again consultation of expert is needed, to identify the species, collect and cultivate in the area earmarked as – Wild Edible Plant Garden.* ***Common/General Suggestions*** *8. All the three action plans will be implemented and developed within the village Gaucher land (land allotted for grazing) or common / community land.* *9. Size and number of plots / plantations / gardens to be developed will be decided in consultation with the newly formed Village Natural Resource Committee – VNRC as well as for the equitable sharing and sustainable use.*

7.7.2. Life Quality Enhancement

Part of Social survey involved in assessing the people's perception on the proposed EIEP project. Even though People discussed about both negative and positive outcomes of the project, apart from the above discussed negative issue on loss and access to natural resource, they also visualized many positive impacts. However, they had an understanding on the need of the project for sustainable utilization of hydro power potential of Arunachal Pradesh, some of their main expectations include job opportunity in the project, additional income sources, better / improved road and transport, education and health care (**Table 6.2**).

People's perception study on the proposed project showed 70% of the villagers in support of project due to their expectation on many developments, related to infrastructure, education, job, health and overall enhancement of life quality. Therefore, it is a prerequisite for project proponent to fulfill the expectations of the locals for development of socially acceptable, economically feasible and ecologically sustainable project.

Providing job opportunity, creations of supplementary income generation sources, health care, improved education very well fall under CRS compliance. Therefore, this section suggests only sources of job in which the affected villagers can be accommodated rather than repeating the existing CSR activities (**Table 7.16).**

7.7.2.1. Job opportunity under CRS activities

Table 7.16: Life Quality Enhancement – Suggested Job Opportunities under CRS Activities

Conservation Theme – Biodiversity Use Values	Action Plan
Secured job for project affected people **Minimise the natural resource dependency** **Improve forest based natural resource**	***1. Job Opportunity in project*** *The families who would lose their land and households should be given priority to provide job.* *The selected persons should be given short-term technical / vocational training based on their qualification and experience and provide them decent jobs like – Welder, Fitter, Plumber, Electrician, Driver and Office assistant, etc* *Unqualified persons (both men and women) can be engaged in other non-technical jobs like;* ***2. Health Care Centre*** • Trained women folk can be given job in the health center as paramedical worker • *Housekeeping* ***3. Project Guest house*** *Housekeeping in the guesthouse / office, Gardener, Assistant in canteen, Security Guards* ***4. Environment Division*** *There are many programs suggested which are related to development of afforestation, habitat restoration, green shelter belt development that are likely to be under the control of the project environment division. Therefore, locals can be engaged in all the plantation works as Plant Nursery Workers after providing them necessary training on nursery technics with the help of an expert.*

7.7.2.2. Creations of supplementary income generation sources

Providing job to the member of all the affected families are not possible, hence it is recommended to support the following **supplementary income generation programmes** so that, the permanent income will bring down the locals' dependency on forest based natural resources. This is a kind of people's biodiversity conservation plan and will also improve their life quality of villagers (**Table 7.17**). The estimated cost of this particular action is Rs.**90,00,000/-,** the details of which are given in **Table 7.23. This should be done with the help of the Eco-Development Committee to be formed**.

Table 7.17: Supplementary Income Generation – Suggested Programmes

Conservation Theme – Biodiversity use values	Action Plan
Self-employment **Additional income** **Improved standard of living**	1. *Cultivation of orange, pineapple and cardamom is a common practice among the locals. Therefore, villagers can be encouraged and facilitated to do large scale vegetable and fruit gardening and thereby increase their income sources.* 2. *All the cultivated products can be procured by the project proponent to cater the needs in colonies, guest house, and mess of the labour camps etc.* 3. *Poultry, piggery, can be other sources of income generation, that can meet the protein requirements of the outsiders.* 4. *Build capacities on improving skills in making arts and crafts and support the local craftsmen and women financially to prepare make and sell the local art and craft material* 5. *The project proponent should also create and support marketing facilities.*

7.7.2.3. Improved Health Care and Education

Providing health care and education are again common infrastructure development under CSR activities, hence this part discussed improved health programmes (**Table 7.18**).

Table 7.18: Additional Facilitation in Health Care and Education

Theme – Life Quality	Actions
Improved health **Increase Literacy Rate**	***Health Care*** **1.** *Development of health center and provide free medicines and quality treatment to the locals* 2. *Operating mobile health care unit in the villages of the project area and special unit for child care are among the expected development of local villagers.* ***In addition, the following health camps can be conducted regularly by involving specialist*** • *Organizing Health Camps* • *Immunization* • *AIDs Awareness programme*

Additional curriculum – Sports and Nature conservation	• *T.B. control* • *Eye Camps* • *Family Planning Camps* • *DOTs, TB eradication Program* ***Education*** *1. The exiting primary school at Etalin should be facilitated with needed infrastructure* *2. Development of secondary school at Etalin, with additional infrastructure suggested to improve the literacy rate of the locals* *3. Providing transport facility for the school – mini school bus* *4. Talented students can be given scholarship for higher education or sponsorship to study in the nearby towns / cities.* *5. Sports and games should be given importance and talented students/persons must be supported to participate in higher level sports meet.* **6.** *Nature education should be the part of special /additional curriculum in the school developed by the project proponent*

7.7.3. People's Biodiversity Register (PBR) – Programme and Awareness Education

Hunting wildlife (major source of protein) and use of forest resource (NTFP and other bamboo, cane and wood materials) are community right. The locals hunt many species of birds (43 species) and mammals (30 species) for their consumption and to some extent for commercial purpose (**Annexure 5.13 & 5.14**). The attitude of commercial use of free resources for additional income is expected to increase many fold due to the influx of large number project manpower / people (outsiders). Hunting being a significant impact and will have direct influence on the population of faunal species, this serious issue should be tackled immediately through series of very strong and effective **awareness programs** for the targeted groups starting with the initiation of preparation of **People's Biodiversity Register – PBR- Programme** (**Table 7.19**), which will aid in documenting all the local biodiversity and the threats faced.

7.7.3.1 People's Biodiversity Register – PBR- Programme

Table 7.19: Initiation of Preparation of People's Biodiversity Register

Conservation Theme – Biodiversity Use Values	Action Plan
Traditional knowledge on biodiversity use values –	The local villagers being tribal communities depend on forest for their livelihood they are the storehouse of traditional knowledge on local biodiversity, which has led to the long-term survival of their generations and the ecosystem they live. But in many places this knowledge even though exists, it is not known. Hence, it is important to document the knowledge on the traditional use of floral and fauna species. This would also help in understanding the past and present overall biodiversity

preserved **Baseline data – long term monitoring**	status of the project area. 1. *Recommended to initiate project on Peoples' Biodiversity Register in all the villages falling within the boundary of the study area and other villages within the radius of 5 km from the boundary of the study area to prepare the PBR by involving a reputed local NGO(s).* 2. *This programme can be initiated in consultation with the State Forest department and State Biodiversity Board (SBB) and the data can be shared with the SBB.* 3. *The outcome can be used as baseline status for long-term monitoring of biodiversity of the project area and develop sustainable plans for its utilization through VNRC & Eco-development Committees (EDCs).* The total cost for implementation of this action plan is **Rs. 25,00,000/-** (**Table 7.23**)

7.7.3.2 Biodiversity Conservation - Awareness Education

7.20. Awareness Education – Biodiversity conservation and Sustainable Resource Use – Targeted Groups

Conservation Theme – Biodiversity Use Values	Action Plan
Conservation education **Sustainable resource use** **Preventing illegal activities**	*Systematic and well planned, series of awareness education camps should be initiated targeting different groups of stakeholders starting from school children, youths, elders of local villages, hunters, migrant project people. This can be done by involving a reputed local NGO with good experience in awareness and education. The themes need to be focused are given below'* ***Local Villagers*** • *sustainable use of the natural resources* • *Non-destructive means of NTFP collection / extraction* • *Regularize the Jhum agriculture through increasing the agriculture productivities by practicing organic forming.* ***Hunter Groups*** • *Possibly regularize periodic / controlled hunting – hunter group* • *Strictly avoiding hunting for commercial use within the community.* • *Community based controlled mechanism needs to be developed to stop the commercial hunting.* • *Education towards avoiding of hunting of Scheduled / Red Listed animals and birds.* ***Migrant Project People*** • *Illegal collection of natural resource*

	• *Avoid cutting of bamboo and trees for timber and fuel wood* • *Not involve in hunting and poaching of wild animals* *Overall awareness on importance of biodiversity conservation and ecosystem service.* The estimated budget for the implementation of this act is **Rs.20,00,000/- (Table 7.23)**

7.7.4. Exploitation of Rare Resource

Paris polyphylla- the rare wild tuber or rhizome found to be overexploited every year by the village youth to make quick and more money. Extensive collection of cane with the help of labour force from Nepal was observed during the field survey. Exploitation without knowing the status of the resource, its potential and productivity, would lead to over exploitation and diminishing / decrease of the resource. Hence, the following actions suggested would help in sustainable use of such rare and highly commercial resources (**Table 7.21**). The estimated cost for this particular action is **Rs.36,00,000/-** (**Table 7.23**).

7.21: Sustainable Use of Rare Resource - *Paris polyphylla and Cane*

Conservation Theme – Biodiversity Use Values	Action Plan
Sustainable use of rare resource	*1. Locals should be made aware of periodic collection of both the resources, viz., once in a four years (Cane) and two years (Paris polyphylla) with the understanding of their productive potential.* *2. It is suggested to take up research and monitoring program to understand the distribution, threats and resource potential of this rare Paris polyphylla with the involvement of local students and derive regulated sustainable management plan.*
Research and knowledge gaining	*3. Measures need to be devised for cultivation or ex-situ re-generation of Paris polyphylla, through research and monitoring. So as to encourage its cultivation.*

7.7.5. Issues related to Migrants on Biodiversity and Culture Values

Illegal Resource Collection and Hunting

One of the impacts of project on natural resource, is its depletion, and conflicts due to sudden increase of 150% of local population due to migrant population, i.e, project associated work force. Their illegal activities in the form of collections forest resources like; wood and bamboo, poaching and hunting pressure is expected to increase many folds. Hence, the above suggested awareness education programme, very strict enforcement of anti-poaching mechanism, can only help in stopping the hunting associated impacts (**Table 7.22**).

Cultural Issues

Other impacts related to migrant population are, influence on cultural values, women safety, unnecessary involvement in tribal's matters, illegal stay, etc. Therefore, these issues need to be monitored and settled in diplomatically. The ways of handling the issues are discussed in **Table 7.22.**

Table 7.22: Measure to Address the Migrant Issues: Hunting and Cultural Values

a. Illegal Resource Collection and Hunting	*1. The outside labour force and labour contractors should be made aware of collection of forest resources and hunting is illegal as per the Wildlife and Forest Protection act.* *2. There should be legal obligation between the contractors and project proponent.* *3. Anti- poaching squad should be formed to strictly monitor the illegal activities, frequently.* *4. Representative of village heads, contractors, project proponent and field staff of forest department are to be part of the anti poaching squad.* *5. Following initial warning, strict actions should be taken to completely stop any kind of illegal activities* *Total cost for implementing this action is **Rs.12,00,000/- (Table 7.23**) and will be done through VNRC & EDC with NGO involvement.*
b. Cultural Issues	• Mass awareness camps for Women Safety • No interference in Tribal matters by project proponents • Women safety can be ensured by district administrators & Project proponent • Inner Line Permit should be properly issued. • Influx of population should be checked and settlement of laborers should be checked. • Contractual labors should not be allowed to stay beyond their contract period. *Cultural issues being sensitive, well informed stakeholders Cultural Issue Committee – CIC should be formed and settled through the local legal forum among the village heads and project proponent heads – Public Relation Officer. Judiciary person can be part of this Cultural Issue Committee – CIC. This should be linked with EDC and the suggested actions need be strictly implemented for which the estimated cost is **Rs.13,00,000/-** (**Table 7.23**).*

7.8. RESEARCH AND MONITORING OF KEY MAMMAL SPECIES MOVEMENTS

Spatial distribution of two ecologically sensitive areas, DWLS and MWLS sanctuaries, were found to be strategically located on the hill ranges and far away from the project sites. Further the movement of key faunal species i.e., Tiger was evaluated, with three studies using camera traps (present survey in the project area; February 2018 – July 2018 and just completed long term study in Dibang Wildlife Sanctuary: 2015 -2017 and ongoing study at Mehao WLS - October 2017 to May 2018 - completed eight months), along with habitat potential of the Etalin HEP-Project study area. The outcome of these studies, did not confim the possibility of occurrence of tiger in the Dri or Tangon project areas. The total estimated cost for carrying out various **Research and Monitoring** projects is **Rs.4,00,00,000/-** (**Table 7.23**).

- Nevertheless, continuous monitoring of movements of key mammalian fauna covering 10km radius from the project study area is very important.
- A competent research organization needs to be engaged for this monitoring research in collaboration with the State Forest Department.

Other Projects related to Ecology

- Monitoring of Aquatic habitat and species of Benthic Invertebrates and Fishes, and other aquatic species along Dri, Trangon and Dibang (below confluence 3-5 km stretch) for five years.
- Monitoring of Bird fauna in and around the Etalin HEP Study Area for minimum of three years covering different seasons is recommended to get a better understanding of their status and conservation problems.
- Ecological survey of the Orchids, Pteridophytes, Lichens, and other lower plants for minimum two years, is of prime importance as to know their status, distribution and conservation problems.
- Status survey of *Paris polyphylla* an overexploited, patchily distributed, economically important plant species in and around the Project study area.
- Monitoring of small mammals using camera traps in the Etalin HEP Study Area for minimum of two years is also another important aspect of biodiversity.
- Two years study on the resource use, availability and means of extraction by local communities needs to be undertaken to get a better understanding of their resource needs and deriving management and sustainable use norms.

All these research and monitoring studies should be for minimum of 3 years to five years. This would help to develop habitat/site, species /species group, and natural resource specific monitoring protocol which is very important for the long-term conservation of the biodiversity in such a mega developmental project in a biodiversity hotspot.

Table 7. 23: Budget Layout for the Implementation of the Biodiversity Management and Wildlife Conservation Plan of the Etalin HEP Study Area

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity Total	Main Activity Total
		1	2	3	4	5		
7.4.1	**Compensatory afforestation ***							
A	Nursery Development & Maintenance 2 no.							* A total of 26.23 Cr has been budgeted as cost of afforestation as part of the Compensatory Afforestation Programme under the EMP (12.2). So this activity may be covered under EMP ensuring that all the subactivities are carriedout
B	Seed Collection							
C	Nursery Water Supply & maintenance							
D	Plantation & Maintenance							
E	Site Preparation - Afforestation Plot (including Protection)							
F	Consultant - Nursery and Plantation Techniques (Training & Guidance) + (travel)							
7.4.2	**Green shelterbelt- Phyto remediation – Dust and Gaseous emission**							**12,00,000**
A	Plantation & Maintenance - include protection)	8,00,000	1,00,000	1,00,000	1,00,000	1,00,000	12,00,000	
7.4.3	**Muck-dump management and Restoration ***							* A total of 114.73 has been budgeted as cost relocation and rehabilitation of excavated material under the EMP (7.5). So this activity may be covered under EMP.
A	Plantation & Maintenance (include Protection)							
7.4.4	**Technical and Managerial Interventions – Noise and Vibration ***							* A total of 50 Lakhs has been budgeted as cost of Noise Mitigation and Management under the EMP (1.4.1.9). So this activity may be covered under EMP.
7.4.5	**Technical and Regulatory Mechanism –**							

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity	Main Activity Total
		1	2	3	4	5	Total	
A	**Road Mortality of wildlife**							**19,00,000**
A	Awareness to Drivers & others	2,00,000					2,00,000	
B	Preparation and Installing Signages – Awareness	15,00,000	50,000	50,000	50,000	50,000	17,00,000	
7.5.1	**Species Group conservation plan – Habitat/ Niche development.**							
7.5.1.1	**Butterfly Parks - 5 No (1-2 ha each)**							**1,30,00,000**
A	Consultant - Guidance & Training in Developing the parks & trainings support staff (6 months)	6,00,000					6,00,000	
B	Head Gardener - 2 nos. (Care & Maintenance)	2,40,000	2,40,000	2,40,000	2,40,000	2,40,000	12,00,000	
C	Assistant Gardner - 10 nos. (Help Head Gardener	8,40,000	8,40,000	8,40,000	8,40,000	8,40,000	42,00,000	
D	Development of Park (Garden including Fencing + plantation)	50,00,000	5,00,000	5,00,000	5,00,000	5,00,000	70,00,000	
7.5.1.2	**Reptile Park – Habitat / Niche- 2 Nos. 5 ha each**							**48,56,000**
A	Consultant - Expertise in Herpetofauna	4,00,000					4,00,000	
B	Setting up parks including protection + artificial burrows + seed sowing grass, herb, runners, shrubs	30,00,000	2,00,000	2,00,000	2,00,000	2,00,000	38,00,000	
C	Setting up walk way (To be planned & laid before dumping rocks and boulders)	2,00,000	25,000	25,000	25,000	25,000	3,00,000	
D	Incorporation of Waste wood	2,00,000					2,00,000	
E	Security Guard – Stop Trespassing	78,000	78,000				1,56,000	
7.5.1.3	**Facilitating & Enhancing Nesting Niche**							
A	Consultant -Technical inputs, Guidance, Training on Cavity Nesting Bird identification, installation & monitoring of Nest Box							* A total of 50 Lakhs has been budgeted as cost of habitat improvement for avifauna under the EMP (1.3.2.2). So this activity may be covered under EMP ensuring that all the
B	Making of Nest Boxes Different Size (total 400 boxes)							
C	Installation & Maintenance							
D	Monitoring of Nest Box - Biologist							

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity	Main Activity Total
		1	2	3	4	5	Total	subactivities are carriedout
E	Field Assistants - 2							
7.5.2	**Habitat Rehabilitation and Restoration –RET Species**							**50,25,000**
A	Mine Dump Restoration Expert (including travel) @ Rs.1.2 lac per month for 4 months	6,00,000	2,00,000				8,00,000	
B	Setting up the Mine Dumps & other post construction phase project land use area & Preparation for Plantation	12,00,000	1,00,000	1,00,000	1,00,000	1,00,000	16,00,000	
C	Nursery & Plantation (Planting and Maintenance including watering)	12,00,000	2,00,000	2,00,000	2,00,000	2,00,000	20,00,000	
D	Labour charges for maintenance - 5 persons 0n daily wage basis	4,00,000	75,000	75,000	75,000		6,25,000	
7.5.3	**Threatened Floral Conservation Plot– TFCP (2-3 ha)**							**29,40,000**
A	Collection of Seeds	1,50,000	50,000	50,000			2,50,000	
B	Nursery Maintenance (including labour)	2,00,000	50,000				2,50,000	
C	Site preparation + Planting + maintenance (watering and de-weeding)	7,50,000	1,00,000	50,000	50,000	50,000	10,00,000	
D	Head Gardener - 1 nos. (Care & Maintenance)	1,20,000	1,20,000	1,20,000	1,20,000	1,20,000	6,00,000	
E	Assistant Gardner - 2 nos (Help Head Gardener	1,68,000	1,68,000	1,68,000	1,68,000	1,68,000	8,40,000	
7.6	**Aquatic Habitat and Biodiversity Conservation – New Roads & Existing Road Expansion**							**1,03,00,000**
A	**Waste Debris Management System – Habitat Quality - Restoration**	65,00,000	15,00,000				80,00,000	
B	Nursery Development & Maintenance	8,00,000					8,00,000	
C	Plantation & Maintenance	12,00,000	2,00,000	1,00,000			15,00,000	
7.7	**Natural resource and life quality enhancement**							**2,05,00,000**
7.7.1	**Grass and leaf fodder plots for Mithun**							
A	To be done on need basis - through VNRC & EDC (Seed Money) lump Sum (all inclusive)	75,00,000	25,00,000				1,00,00,000	

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity Total	Main Activity Total
		1	2	3	4	5		
7.7.1	**Bamboo plantation**							
B	To be done on need basis - through VNRC & EDC (Seed Money) lump Sum (all inclusive)	50,00,000	20,00,000				70,00,000	
7.7.1	**Wild edible plant garden**							
C	One in each village - to be done - through VNRC & EDC (Seed Money) lump Sum (all inclusive)	25,00,000	10,00,000				35,00,000	
7.7.2	**Life Quality Enhancement ***							* This activity may be taken as per the project's R& R Plan ensuring all the subactivities are covered
7.7.2.1	**Providing job opportunities (involved in jobs to be created in the project and also in the implementation of BMCP**							
7.7.2.2	**Create Income generation sources /options**							
A	Capacity building in making crafts - improve skills (To be done under EDC program)							
B	Seed money as Loan for setting up / improving business, developing fruit orchards (Under Purview of EDC) – part of livelihood enhancement							
7.7.2.3	**Improved Health Care & Education– part of CSR**							
A	**Improved Health Care**							
B	**Improved education facilities -**							
C	**Encourage sports and games -**							
7.7.3	**Peoples' Biodiversity Register & Awareness Education Programs**							**40,00,000**
7.7.3.1	**People biodiversity Register**							
A	NGO to be involved (take assistance / help of VNRC)	25,00,000					25,00,000	
7.7.3.2	**Awareness - Sustainable Resource Use & Regulation on Hunting of Wild animals**							
A	NGO to be involved - Developing Protocol & Awareness Program (assistance of VNRC & EDC)	10,00,000	5,00,000				15,00,000	

S.No	Activities / Actions	Yearly Break up - Five Years					Sub-Activity Total	Main Activity Total
		1	2	3	4	5		
7.7.4	**Sustainable Use of Rare Resource - *Paris polyphylla* and Cane**							**36,00,000**
A	Awareness on sustainable use	4,00,000	1,00,000	1,00,000			6,00,000	
B	*Understand the distribution, threats and resource potential of Paris polyphylla* and Cane	6,00,000	6,00,000	3,00,000			15,00,000	
C	Experiment – growing *P. polyphylla in ex-situ village land including management*	10,00,000	5,00,000				15,00,000	
7.7.5	**Issues related to Migrants on Biodiversity and Culture Values**							**25,00,000**
A	**Anti-poaching Mechanism**							
	To be done through VNRC & EDC & NGO							
	Signages on effects of hunting and significance of conserving biodiversity	12,00,000					12,00,000	
B	**Stakeholders Interaction – Cultural Values - CIC & EDC**	3,00,000	3,00,000	2,00,000	2,00,000	3,00,000	13,00,000	
7.8	**ESA- Research and Monitoring**	1,60,00,000	60,00,000	60,00,000	60,00,000	60,00,000	4,00,00,000	**4,00,00,000**
Total		**6,43,46,000**	**1,82,96,000**	**94,18,000**	**88,68,000**	**88,93,000**	**10,98,21,000**	**10,98,21,000**

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ANNEXURES

Annexure 5.1: Plant Species recorded in the Etalin HEP Study Area

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
1	**Acanthaceae**							
1	*Andrographis paniculata*	H				++	**	
2	*Anisomeles indica*	H		+	+	++	***	
3	*Asystasia neesiana*	H				++	**	
4	*Justicia adhatoda*	S		+	+	++	***	
5	*Justicia mollissima*	H		2	2	++	***	
6	*Justicia parvifolia*	H				++	**	
7	*Phlogacanthus curviflorus*	S	2	33	35		*	
8	*Phlogacanthus tubiflorus*	S	+	+	+	++	***	
9	*Strobilanthes coloratus*	S				++	**	
10	*Strobilanthes sp*	S	129	16	145		*	
11	*Strobilanthes rhombifolia*	H				++	**	
12	*Thunbergia coccinea*	C		+	+		*	
2	**Achariaceae**							
13	*Gynocardia odorata*	T	1	4	5	++	***	
3	**Acoraceae**							
14	*Acorus calamus*	H				++	**	
4	**Actinidiaceae**							
15	*Saurauia fasciculata*	T	+		+		*	
16	*Saurauia griffithii*	T	11	3	14		*	
17	*Saurauia napaulensis*	T	14	9	23		*	
5	**Adoxaceae**							
18	*Viburnum nervosum*	T				++	**	
19	*Sambucus javanica*	T		+	+		*	
20	*Sambucus hookeri*		7	15	22		*	
6	**Altingiaceae**							
21	*Altingia excelsa*	T	3	3	6		*	
7	**Amaranthaceae**							
22	*Achyranthes bidentata*	H	16	18	34	++	***	
23	*Amaranthus hybridus*	H	+	+	+	++	***	
24	*Amaranthus viridis*	H		+	+	++	***	
25	*Cyathula prostrata*	H				++	**	
8	**Anacardiaceae**							
26	*Lannea coromandelica*	T				++	**	
27	*Mangifera sylvatica*	T				++	**	
28	*Pegia nitida*	C	+		+		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
29	*Rhus wallichiana*	T	+		+	++	***	
30	*Spondias pinnata*	T				++	**	
9	**Apiaceae**							
31	*Centella asiatica*	H		+	+	++	***	
32	*Heracleum peucedanum*	H	+		+		*	
33	*Oenanthe javanica*	H		+	+	++	***	
10	**Apocynaceae**							
34	*Beaumontia grandiflora*	S		+	+		*	
35	*Carissia*	C	12	11	23		*	
36	*Cascabela thevetia*	S				++	**	
37	*Hoya globulosa*	C	+		+		*	
38	*Marsdenia tinctoria*	C	+		+		*	
11	**Araceae**							
39	*Aglaonema hookerianum*	H				++	**	
40	*Alocasia fallax*	H				++	**	
41	*Alocasia fornicata*	H	+	+	+	++	***	
42	*Ariopsis peltata*	H				++	**	
43	*Arisaema concinnum*	H	2	6	8	++	***	
44	*Arisaema decipiens*	H	+		+	++	***	
45	*Arisaema jacquemontii*	H	11	11	22	++	***	
46	*Arisaema nepenthoides*	H		2	2	++	***	
47	*Arisaema propinquum*	H		+	+	++	***	
48	*Arisaema speciosum*	H				++	**	
49	*Lasia spinosa*	H				++	**	
50	*Pothos scandens*	C	+	+	+	++	***	
51	*Rhaphidophora decursiva*	C	95	73	168	++	***	
52	*Rhaphidophora glauca*	C	0	0	0		*	
53	*Rhaphidophora hookeri*	C	10	51	61		*	
12	**Araliaceae**							
54	*Aralia armata*	T	6	21	27	++	***	
55	*Brassaiopsis glomerulata*	T	+			++	***	
56	*Brassaiopsis hainla*	T	10	18	28		*	
57	*Brassaiopsis simplicifolia*	T	0	10	10		*	
58	*Hydrocotyle himalaica*	H	5	4	9		*	
59	*Macropanax dispermus*	T	6	1	7	++	***	
60	*Macropanax undulatus*	T	0	1	1	++	***	
61	*Parapentapanax subcordatum*	T				++	**	
62	*Schefflera hypoleuca*	C		3	3	++	***	
63	*Trevesia palmata*	T	4	6	11	++	***	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
13	**Arecaceae**							
64	*Calamus erectus*	C				++	**	
65	*Calamus flagellum*	C		5	5	++	***	
66	*Calamus floribundus*	C		6	6	++	***	
67	*Calamus leptospadix*	C		1	1	++	***	
68	*Calamus nambariensis*	C				++	**	
69	*Calotropis gigantea*	S				++	**	
70	*Caryota urens*	T	6	6	12	++	***	
71	*Livistona jenkinsiana*	T				++	**	
72	*Marsdenia roylei*	S				++	**	
73	*Periploca calophylla*	C	27		27		*	
74	*Wallichia oblongifolia*	S	0	2	2		*	
14	**Asparagaceae**							
75	*Chlorophytum tuberosum*	H				++	**	
76	*Maianthemum oleraceum*	H	+		+		*	
77	*Ophiopogon intermedius*	H	62	14	76		*	
15	**Asteraceae**							
78	*Acmella oleracea*	H	+	+	+	++	***	
79	*Ageratum conyzoides*	H	23	5	28	++	***	
80	*Anaphalis busua*	H				++	**	
81	*Anaphalis contorta*	H		+	+	++	***	
82	*Artemisia indica*	H	44	23	67	++	***	
83	*Artemisia maritima*	H				++	**	
84	*Artemisia nilagirica*	H		+	+	++	***	
85	*Aster himalaicus*	H				++	**	
86	*Bidens biternata*	H	23		23	++	***	
87	*Bidens pilosa*	H	6		6	++	***	
88	*Blumea*	H		4	4		*	
89	*Blumea trieracifolia var. macrostachya*	H		+	+		*	
90	*Blumea fistulosa*	H		+	+		*	
91	*Blumea pannosa*	H				++	**	
92	*Crassocephalum crepidioides*	C	+	+	+	++	***	
93	*Erigeron bonariensis*	H		+	+		*	
94	*Eupatorium odoratissimum*	H	+		+	++	***	
95	*Gynura nepalensis*	H		+	+	++	***	
96	*Innula*	H		1	1		*	
97	*Lactuca virosa*	H				++	**	
98	*Laphangium affine*	H		+	+	++	***	
99	*Mikania micrantha*	C				++	**	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
100	*Senecio cappa*	H		+	+	++	***	
101	*Sigesbeckia orientalis*	H	+	+	+	++	***	
102	*Sonchus oleraceus*	H	+	+	+	++	***	
103	*Spilanthes paniculata*	H	9	2	11	++	***	
104	*Tagetes minuta*	H		+	+	++	***	
105	*Xanthium*	H	1		1		*	
106	*Youngia japonica*	H		+	+		*	
16	**Balsaminaceae**							
107	*Impatiens acuminata*	H		+	+	++	***	
108	*Impatiens arguta*	H	66	43	109		*	
109	*Impatiens bicornuta*	H				++	**	
110	*Impatiens brachycentra*	H				++	**	
111	*Impatiens dolichoceras*	H		+	+		*	
112	*Impatiens racemosa*	H	+	+	+	++	***	
113	*Impatiens stenantha*	H		+	+		*	
114	*Impatiens xanthina*	H	+		+		*	
17	**Basellaceae**							
115	*Basella alba*	H				++	**	
18	**Begoniaceae**							
116	*Begonia cathcartii*	H	+	+	+		*	
117	*Begonia griffithiana*	H		3	3		*	
118	*Begonia longifolia*	H	3	4	7		*	
119	*Begonia nepalensis*	H				++	**	
120	*Begonia palmata*	H		+	+	++	***	
121	*Begonia roxburghii*	H				++	**	
19	**Betulaceae**							
122	*Alnus nepalensis*	T	0	3	3	++	***	
123	*Alnus nitida*	T	1	3	4		*	
20	**Bignoniaceae**							
124	*Oroxylum indicum*	T				++	**	
125	*Stereospermum chelonoides*	T	3	2	5		*	
21	**Boraginaceae**							
126	*Cordia dichotoma*	T	1	2	3		*	
127	*Cynoglossum wallichii*	H		+	+		*	
128	*Ehretia wallichiana*	T	1	0	1		*	
129	*Trigonotis microcarpa*	H		+	+		*	
22	**Brassicaceae**							
130	*Cardamine hirsuta*	H	+	+	+	++	***	
23	**Buddlejaceae**							

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
131	*Buddleja asiatica*	H	+		+	++	***	
24	**Burseraceae**							
132	*Canarium strictum*	T				++	**	
133	*Garuga floribunda*	T				++	**	
25	**Cactaceae**							
134	*Opuntia dillenii*	H		+	+	++	***	
26	**Campanulaceae**							
135	*Campanumaea parviflora*	H				++	**	
136	*Lobelia succulenta*	H				++	**	
27	**Cannabaceae**							
137	*Cannabis sativa*	H	+	+	+	++	***	
138	*Celtis tetrandra*	T	0	2	2		*	
139	*Trema orientalis*	T	2	8	10		*	
28	**Cannaceae**							
140	*Canna indica*	H				++	**	
29	**Capparaceae**							
141	*Capparis multiflora*	S		+	+		*	
30	**Caprifoliaceae**							
142	*Valeriana jatamansi*	H	+		+		*	
31	**Caryophyllaceae**							
143	*Cerastium cerastoides*	H				++	**	
144	*Drymaria cordata*	H	5	13	18	++	***	
145	*Stellaria monosperma*	H	4	15	19	++	***	
32	**Chloranthaceae**							
146	*Chloranthus elatior*	S	3	20	23		*	
33	**Clusiaceae**							
147	*Garcinia cowa*	T				++	**	
148	*Garcinia elliptica*	T	3	10	13		*	
149	*Garcinia stipulata*	T				++	**	
150	*Mesua assamica*	T				++	**	
34	**Colchicaceae**							
151	*Disporum calcaratum*	H	14		14		*	
152	*Disporum cantoniense*	H	+		+		*	
35	**Combretaceae**							
153	*Terminalia bellirica*	T	0	2	2	++	***	
154	*Terminalia chebula*	T		+	+	++	***	
155	*Terminalia myriocarpa*	T	1	4	5	++	***	
36	**Commelinaceae**							
156	*Amischotolype mollissima*	H		1	1		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
157	*Commelina appendiculata*	H		2	2	++	***	
158	*Commelina benghalensis*	H	15	20	35	++	***	
159	*Cyanotis cristata*	H	+	+	+	++	***	
160	*Cyanotis vaga*	H	+	+	+	++	***	
161	*Murdannia nudiflora*	H				++	**	
162	*Streptolirion volubile*	C	7	12	19		*	
37	**Convolvulaceae**							
163	*Argyreia nervosa*	C				++	**	
164	*Ipomoea batatas*	H				++	**	
165	*Ipomoea fistulosa*	H				++	**	
166	*Ipomoea nil*	C				++	**	
167	*Porana paniculata*	C				++	**	
38	**Coriariaceae**							
168	*Coriaria nepalensis*	S	1	0	1		*	
39	**Costaceae**							
169	*Cheilocostus speciosus*	H				++	**	
40	**Cucurbitaceae**							
170	*Hodgsonia macrocarpa*	C		1	1	++	***	
171	*Momordica cochinchinensis*	C	+	+	+	++	***	
172	*Neoalsomitra clavigera*	C		1	1		*	
173	*Solena amplexicaulis*	C	2	11	13	++	***	
174	*Solena heterophylla*	C	+	+	+	++	***	
175	*Thladiantha capitata*	C		+	+	++	***	
176	*Thladiantha cordifolia*	C	2	4	6		*	
41	**Cyperaceae**							
177	*Carex baccans*	Sg	0	1	1		*	
178	*Carex longipes*	Sg		+	+	++	***	
179	*Carex thomsonii*	Sg		+	+		*	
180	*Cyperus alulatus*	Sg				++	**	
181	*Cyperus exaltatus*	Sg				++	**	
182	*Cyperus rotundus*	Sg	1	0	1	++	***	
183	*Kyllinga brevifolia*	Sg				++	**	
184	*Scleria* sp	Sg	0	9	9		*	
42	**Dilleniaceae**							
185	*Dillenia indica*	T				++	**	
186	*Dillenia scabrella*	T				++	**	
43	**Dioscoreaceae**							
187	*Dioscorea glabra*	C	+		+	++	***	
188	*Dioscorea pentaphylla*	C		2	2	++	***	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
189	*Dioscorea belophylla*	C				++	**	
190	*Dioscorea alata*	C				++	**	
44	**Dipterocarpaceae**							
191	*Dipterocarpus gracilis*	T				++	**	
45	**Ebenaceae**							
192	*Diospyros lanceifolia*	T	5	10	15		*	
46	**Elaeocarpaceae**							
193	*Elaeocarpus floribundus*	T		+	+	++	***	
47	**Ericaceae**							
194	*Agapetes forrestii*	S				++	**	
195	*Agapetes griffithii*	S				++	**	
196	*Gaultheria codonantha*	C	+		+		*	
197	*Lyonia ovalifolia*	T	3	0	3		*	
198	*Vaccinium vacciniaceum*	S	+		+		*	
48	**Euphorbiaceae**							
199	*Croton triqueter*	S		+	+		*	
200	*Euphorbia pulcherrima*	S				++	**	
201	*Macaranga denticulata*	T	26	7	33	++	***	
202	*Mallotus philippensis*	T				++	**	
203	*Mallotus sp*	T	0	2	2		*	
204	*Ostodes paniculata*	T	19	18	47	++	***	
205	*Ricinus communis*	S		+	+	++	***	
49	**Fabaceae**							
206	*Acacia pinnata*	C	4	12	16	++	***	
207	*Acacia pruinescens*	T				++	**	
208	*Acrocarpus fraxinifolius*	T				++	**	
209	*Albizia chinensis*	T	5	3	8	++	***	
210	*Albizia lucidior*	T				++	**	
211	*Albizia procera*	T	0	1	1	++	***	
212	*Bauhinia ovatifolia*	C	+		+	++	***	
213	*Bauhinia purpurea*	T		+	+	++	***	
214	*Caesalpinia spinosa*	C		+	+	++	***	
215	*Cassia*	S	0	6	6		*	
216	*Cassia notabilis*	S				++	**	
217	*Dalbergia pinnata*	T	0	1	1	++	***	
218	*Dalea purpurea*	H	+		+		*	
219	*Desmodium laxiflorum*	S	1	0	1	++	***	
220	*Entada phaseoloides*	C	11	8	19	++	***	
221	*Erythrina variegata*	T	+	+	+	++	***	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
222	*Indigofera sp.*	S	1	0	1		*	
223	*Maniltoa polyandra*	C				++	**	
224	*Millettia podocarpa*	C	19	2	21		*	
225	*Mucuna bracteata*	C	11	6	17	++	***	
226	*Pueraria wallichii*	H				++	**	
227	*Senna occidentalis*	S	+		+	++	***	
228	*Shuteria involucrata*	C	+	+	+		*	
229	*Suphora sp.*	S	3	1	4		*	
50	**Fagaceae**							
230	*Castanopsis hystrix*	T				++	**	
231	*Castanopsis indica*	T	41	58	99	++	***	
232	*Castanopsis lanceifolia*	T				++	**	
233	*Castanopsis tribuloides*	T	21	1	22	++	***	
234	*Lithocarpus dealbatus*	T	28	6	34	++	***	
235	*Lithocarpus elegans*	T	0	1	1		*	
236	*Lithocarpus falconeri*	T				++	**	
237	*Lithocarpus fenestratus*	T	22	0	22	++	***	
238	*Lithocarpus listeri*	T	1	5	6		*	
239	*Lithocarpus pachyphyllus*	T	14	9	23	++	***	
240	*Quercus semiserrata*	T	0	1	1		*	
51	**Gentianaceae**							
241	*Exacum tetragonum*	H				++	**	
52	**Gesneriaceae**							
242	*Aeschynanthus acuminatus*	H		+	+		*	
243	*Chirita macrophylla*	H	+	+	+		*	
244	*Henckelia dibangensis*	H		+	+		*	
245	*Henckelia oblongifolia*	S	0	4	4		*	
246	*Loxostigma griffithii*	H		+	+		*	
247	*Platystemma violoides*	H				++	**	
248	*Rhynchotechum ellipticum*	S	29	47	76		*	
53	**Hamamelidaceae**							
249	*Exbucklandia cordifolia*	T	7	0	7		*	
54	**Hydrangeaceae**							
250	*Hydrangea serratifolia*	S				++	**	
251	*Hydrangea robusta*	S	1	0	1		*	
55	**Hypericaceae**							
252	*Hypericum hookerianum*	S				++	**	
56	**Hypoxidaceae**							
253	*Molineria capitulata*	H	13	49	62		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
57	**Icacinaceae**							
254	*Natsiatum herpeticum*	S	+		+		*	
58	**Iteaceae**							
255	*Itea macrophylla*	T	2	0	2	++	***	
256	*Itea* sp.	C	1	2	3		*	
59	**Juglandaceae**							
257	*Engelhardtia spicata*	T	39	7	46	++	***	
60	**Lamiaceae**							
258	*Achyrospermum densiflorum*	H	44	9	53		*	
259	*Ajuga macrosperma*	H	23	8	31	++	***	
260	*Callicarpa arborea*	T	3	1	4	++	***	
261	*Clinopodium capitellatum*	H				++	**	
262	*Elsholtzia ciliata*	H		+	+	++	***	
263	*Leucas aspera*	H	3		3	++	***	
264	*Leucas ciliata*	H				++	**	
265	*Plectranthus strigosus*	S				++	**	
266	*Pogostemon benghalensis*	H	+		+	++	***	
267	*Premna barbata*	H	+	+	+		*	
268	*Premna bengalensis*	T	+		+	++	***	
269	*Vitex altissima*	T	1	0	1		*	
61	**Lauraceae**							
270	*Actinodaphne obovata*	T	3	9	12	++	***	
271	*Cinnamomum bejolghota*	T				++	**	
272	*Cinnamomum glanduliferum*	T				++	**	
273	*Cinnamomum sulphuratum*	T	3	0	3	++	***	
274	*Lindera neesiana*	T	1	0	1		*	
275	*Litsea cubeba*	T	54	29	83		*	
276	*Litsea mishmiensis*	T	0	4	4		*	
277	*Litsea monopetala*	T	0	2	2		*	
278	*Litsea salicifolia*	T	+		+		*	
279	*Phoebe cooperiana*	T	0	6	6	++	***	
62	**Loranthaceae**							
280	*Helixanthera ligustrina*	S	0	1	1		*	
281	*Helixanthera parasitica*	S	+		+		*	
282	*Taxillus vestitus*	S	+		+		*	
63	**Lythraceae**							
283	*Duabanga grandiflora*	T				++	**	
284	*Lagerstroemia minuticarpa*	T				++	**	
285	*Lagerstroemia parviflora*	T	1	0	1	++	***	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
64	**Magnoliaceae**							
286	*Magnolia campbellii*	T				++	**	
287	*Magnolia griffithii*	T				++	**	
288	*Michelia excelsa*	T				++	**	
289	*Michelia champava*	T		+	+	++	***	
290	*Talauma hodgsonii*	T				++	**	
65	**Malvaceae**							
291	*Abutilon indicum*	H				++	**	
292	*Bombax ceiba*	T				++	**	
293	*Grewia serrulata*	T				++	**	
294	*Kydia calycina*	T	5	8	13	++	***	
295	*Pterospermum acerifolium*	T	7	0	7	++	***	
296	*Sida rhombifolia*	H		+	+	++	***	
297	*Sterculia villosa*	T				++	**	
298	*Triumfetta abyssinica*	S				++	**	
299	*Urena lobata*	H	1		1	++	***	
66	**Melastomataceae**							
300	*Melastoma malabathricum*	S				++	**	
301	*Osbeckia nutans*	H				++	**	
302	*Osbeckia stellata*	H				++	**	
303	*Oxyspora paniculata*	S	13	9	22	++	***	
304	*Sarcopyramis napalensis*	H	+		+		*	
67	**Meliaceae**							
305	*Aglaia spectabilis*	T				++	**	
306	*Chukrasia tabularis*	T				++	**	
307	*Dysoxylum mollissimum*	T	1	9	10	++	***	
308	*Toona hexandra*	T	0	1	1	++	***	
68	**Menispermaceae**							
309	*Cissampelos pareira*	C	+	+	+	++	***	
310	*Diploclisia glaucescens*	H				++	**	
311	*Stephania elegans*	C	21	7	28	++	***	
312	*Tinospora crispa*	C				++	**	
69	**Moraceae**							
313	*Artocarpus chama*	T	2	0	2	++	***	
314	*Ficus roxburghii*	T	1	7	8	++	***	
315	*Ficus sp*	T	0	1	1		*	
316	*Ficus cuneata*	T				++	**	
317	*Ficus cyrtophylla*	T	0	5	5		*	
318	*Ficus heterophylla*	T	+	+	+	++	***	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
319	*Ficus hookeriana*	T	0	4	4		*	
320	*Ficus lacor*	T	+		+		*	
321	*Ficus semicordata*	T	21	25	46	++	***	
322	*Maclura cochinchinensis*	T	3		3		*	
323	*Morus macroura*	T				++	**	
70	**Musaceae**							
324	*Musa acuminata*	H		+	+	++	***	
325	*Musa balbisiana*	H		+	+	++	***	
326	*Musa paradisiaca*	H				++	**	
71	**Myristicaceae**							
327	*Knema cinerea*	T	0	6	6		*	
72	**Marantaceae**							
334	*Phrynium pubinerve*	H						
73	**Myrtaceae**							
328	*Psidium guajava*	T		+	+	++	***	
329	*Syzygium formosum*	T		+	+	++	***	
74	**Oleaceae**							
330	*Jasminum elongatum*	S				++	**	
331	*Jasminum dispermum*	H				++	**	
332	*Jasminum laurifolium*	S	+	+	+		*	
75	**Orchidaceae**							
333	*Aerides multiflora*	O				++	**	
334	*Anoectochilus brevilabris*	O		+	+		*	
335	*Arundina graminifolia*	O				++	**	
336	*Bulbophyllum affine*	O	+		+	++	***	
337	*Bulbophyllum careyanum*	O				++	**	
338	*Bulbophyllum cauliflorum*	O				++	**	
339	*Bulbophyllum guttulatum*	O				++	**	
340	*Calanthe griffithii*	O				++	**	
341	*Calanthe plantaginea*	O	+		+		*	
342	*Coelogyne barbata*	O				++	**	
343	*Coelogyne corymbosa*	O				++	**	
344	*Coelogyne stricta*	O	+		+		*	
345	*Cymbidium aloeifolium*	O	+	+	+	++	***	
346	*Cymbidium cyperifolium*	O				++	**	
347	*Cymbidium eburneum*	O				++	**	
348	*Cymbidium elegans*	O				++	**	
349	*Cymbidium iridioides*	O				++	**	
350	*Cymbidium lancifolium*	O	4	0	4		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
351	*Dendrobium densiflorum*	O				++	**	
352	*Dendrobium hookerianum*	O				++	**	
353	*Dendrobium lituiflorum*	O				++	**	
354	*Dendrobium moschatum*	O				++	**	
355	*Dendrobium transparens*	O	+	+	+		*	
356	*Epipogium roseum*	O		+	+		*	
357	*Eria flava*	O				++	**	
358	*Goodyera procera*	O	0	2	2	++	***	
359	*Lepanthes pedunculata*	O				++	**	
360	*Liparis delicatula*	O	+		+	++	***	
361	*Phaius flavus*	O				++	**	
362	*Pholidota imbricata*	O				++	**	
363	*Pholidota sp.*							
364	*Rhynchostylis retusa*	O				++	**	
365	*Spiranthes sinensis*	O				++	**	
366	*Tropidia curcugiloides*	O	+	+	+		*	
367	*Vanda cristata*	O		+	+		*	
76	**Oxalidaceae**							
368	*Averrhoa carambola*	T				++	**	
369	*Oxalis corniculata*	H		10	10		*	
77	**Papaveraceae**							
370	*Corydalis geraniifolia*	H				++	**	
78	**Pandanaceae**							
371	*Pandanus odoratissimus*	T	5	11	16	++	***	
79	**Pentaphylacaceae**							
372	*Eurya acuminata*	T	+	+	+		*	
373	*Eurya trichocarpa*	T	+	+	+		*	
374	*Eurya nitida*	T	3	2	5		*	
80	**Phyllanthaceae**							
375	*Bischofia javanica*	T	+	+	+	++	***	
376	*Bridelia retusa*	T	1	0	1		*	
377	*Glochidion zeylanicum*	T	+		+		*	
81	**Piperaceae**							
378	*Piper graeffei*	S				++	**	
379	*Piper betle*	C	4		4	++	***	
380	*Piper kadsura*	C	9	33	42		*	
381	*Piper petiolatum*	C	21	34	55		*	
382	*Piper attenuatamentum*	C		8	8		*	
383	*Piper clarkei*	C	31	27	58		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
384	*Piper pedicellatum*	S	112	139	251		*	VU
385	*Piper rhytidocarpum*	C		17	17		*	
386	*Piper sylvestre*	C	19	22	41		*	
82	**Plantaginaceae**							
387	*Plantago asiatica subsp. erosa*	H		+	+		*	
388	*Veronica anagallis-aquatica*	S	12	3	15	++	***	
83	**Poaceae**							
389	*Arundinaria falcata*	G				++	**	
390	*Bambusa balacoa*	G		+	+		*	
391	*Bambusa pallida*	G		+	+	++	***	
392	*Bambusa tulda*	G		+	+	++	***	
393	*Cephalostachyum latifolium*	G				++	**	
394	*Chimonobambusa callosa*	G				++	**	
395	*Coix lacryma-jobi*	G		+	+		*	
396	*Cynodon dactylon*	G	+	+	+	++	***	
397	*Dendrocalamus*	B	0	22	22		*	
398	*Dendrocalamus giganteus*	B		+	+	++	***	
399	*Dendrocalamus hamiltonii*	B		+	+	++	***	
400	*Dendrocalamus strictus*	B		+	+	++	***	
401	*Imperata cylindrica*	G	+	+	+	++	***	
402	*Miscanthus sp.*	G	5	0	5		*	
403	*Miscanthus sinensis*	G	+	+	+	++	***	
404	*Neomicrocalamus prainii*	G	0	1	1		*	
405	*Oplismenus compositus*	G	0	3	3		*	
406	*Oplismenus hirtellus*	G	76	53	129		*	
407	*Phragmites karka*	G	+	+	+	++	***	
408	*Phyllostachys bambusoides*	G		+	+		*	
409	*Poa annua*	G				++	**	
410	*Pogonatherum paniceum*	G	+	+	+	++	***	
411	*Pogostemon elsholtzionides*	G		+	+		*	
412	*Saccharum sp.*							
413	*Saccharum spontaneum*	G	+	+	+	++	***	
414	*Schizostachyum capitatum*	G				++	**	
415	*Schizostachyum polymorphum*	G				++	**	
416	*Setaria palmifolia*	G	+		+		*	
417	*Stapletonia arunachalensis*	G	2	1	3		***	
418	*Themeda anathera*	G	+	+	+	++	***	
419	*Thysanolaena latifolia*	G	+	+	+	++	***	
84	**Polygalaceae**							

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
420	*Polygala watresii*	S	2	0	2		*	
85	**Polygonaceae**							
421	*Fagopyrum dibotrys*	H	50	3	53	++	***	
422	*Persicaria capitata*	H	23	2	25	++	***	
423	*Persicaria chinensis*	H	31		31	++	***	
424	*Polygonum auriculatum*	H	+		+		*	
425	*Polygonum chiloensis*	H	5		5		*	
426	*Polygonum fallacinum*	H				++	**	
427	*Polygonum molle*	H	1	18	19		*	
428	*Polygonum runcinatum*	H	+		+		*	
429	*Polypogon monspeliensis*	H	24		24		*	
86	**Primulaceae**							
430	*Ardisia japonica*	S	6	0	6		*	
431	*Embelia ribes*	C	+	+	+	++	***	
432	*Embelia floribunda*	C	25		25		*	
433	*Maesa chisia*	T	76	19	95	++	***	
434	*Maesa indica*	T	19	8	27	++	***	
435	*Myrsine semiserrata*	S	3	0	3	++	***	
87	**Ranunculaceae**							
436	*Clematis acuminata*	C	2	4	24		*	
437	*Clematis gouriana*	C		+	+	++	***	
438	*Clematis grata*	C	+	+	+		*	
439	*Coptis teeta*	H				++	**	
440	*Fragaria indica*	H	36	7	43		*	
441	*Ranunculus sikkimensis*	H				++	**	
88	**Rhamnaceae**							
442	*Hovenia acerba*	T				++	**	
443	*Rhamnus napalensis*	S				++	**	
444	*Ventilago maderaspatana*	C	+		+		*	
89	**Rosaceae**							
445	*Agrimonia pilosa*	H		+	+	++	***	
446	*Aruncus sp*	H		2	+		*	
447	*Photinia wardii*	S		+	+		*	
448	*Potentilla microphylla*	H				++	**	
449	*Prunus rufa*	T	+		+		*	
450	*Rubus burkillii*	S				++	**	
451	*Rubus ellipticus*	S	25	0	25	++	***	
452	*Rubus foliosus*	S	+	+	+	++	***	
453	*Rubus navus*	S	2	0	2		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
454	*Rubus parviflorus*	C	2		2		*	
455	*Rubus rosifolius*	S	+	+	+		*	
90	**Rubiaceae**							
456	*Chassalia curviflora var. ophioxyloides*	S	+		+		*	
457	*Hedyotis scandens*	C	+	+	+		*	
458	*Ixora sp.*	S	0	6	6		*	
459	*Luculia pinceana*	S				++	**	
460	*Mussaenda incana*	S	0	1	1		*	
461	*Mussaenda roxburghii*	S	+	+	+		*	
462	*Mycetia stipulata*	S	+		+		*	
463	*Ophiorrhiza mungos*	S	0	9	9		*	
464	*Ophiorrhiza parviflora*	S		+	+		*	
465	*Paederia foetida*	C	+	+	+	++	***	
466	*Psychotria monticola*	S	114	38	152		*	
467	*Rubia sikkimensis*	C	6	1	7		*	
468	*Rubiaceae shrub (Gardenia?)*	S	0	12	12		*	
469	*Uncaria pilosa*	C	+		+		*	
470	*Wenlandia wallichii*	S	+		+		*	
91	**Rutaceae**							
471	*Acronychia pedunculata*	S	+		+		*	
472	*Citrus aurantium*	T				++	**	
473	*Citrus limon*	T				++	**	
474	*Murraya paniculata*	S	+		+	++	***	
475	*Toddalia asiatica*	C		3	3		*	
476	*Zanthoxylum armatum*	S	0	2	2	++	***	
92	**Sabiaceae**							
477	*Meliosma simplicifolia*	T	1	0	1		*	
478	*Sabia lanceolata*	C	+		+		*	
93	**Salicaceae**							
479	*Casearia vareca*	T	4	0	4		*	
480	*Populus gamblei*	T	+		+	++	***	
94	**Sapindaceae**							
481	*Acer laurinum*	T	+		+		*	
482	*Nephedium sp.*	T	0	4	4		*	
95	**Sapotaceae**							
483	*Diploknema butyraceoides*	T	0	17	17		*	
484	*Sarcosperma griffithii*	T				++	**	
96	**Saururaceae**							
485	*Houttuynia cordata*	H	45		45		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
97	**Saxifragaceae**							
486	*Saxifraga sarmentosa var. cuscutiformis*	S				++	**	
98	**Scrophulariaceae**							
487	*Lindenbergia indica*	H	+	+	+	++	***	
488	*Mazus pumilus*	H	+	+	+	++	***	
99	**Simaroubaceae**							
489	*Ailanthus excelsa*	T	11	0	11		*	
490	*Ailanthus integrifolia*	T	+	+	+	++	***	
491	*Alangium begoniifolium*	T				++	**	
100	**Smilacaceae**							
492	*Smilax aspera*	C	23	10	33	++	***	
493	*Smilax lanceifolia*	C	+	+	+		*	
494	*Smilax glabra*	C		3	3		*	
495	*Smilax opposifolia*	C	10	8	18		*	
496	*Smilax perfoliata*	C		2	2		*	
497	*Smilax petelotii*	C		1	1		*	
101	**Solanaceae**							
498	*Datura suaveolens*	S		+		++	**	
499	*Lycianthes laevis*	S		+	+		*	
500	*Lycianthes rantonnei*	S				++	**	
501	*Nicandra physalodes*	H	+		+	++	***	
502	*Nicotiana tabaccum*	H	+		+		*	
503	*Physalis minima*	H				++	**	
504	*Physalis peruviana*	H				++	**	
505	*Solanum ciliatum*	H				++	**	
506	*Solanum echinatum*	H	13	3	16		*	
507	*Solanum indicum*	H	+	+	+	++	***	
508	*Solanum nigricans*	H	+	+	+	++	***	
509	*Solanum spirale*	S	13	4	17		*	
510	*Solanum viarum*	H				++	**	
102	**Staphyleaceae**							
511	*Turpinia napalensis*	C	+	+	+		*	
512	*Turpinia pomifera*	C	+	+	+		*	
103	**Tetramelaceae**							
513	*Tetrameles nudiflora*	T	+	+	+	++	***	
104	**Theaceae**							
514	*Camilia*	S	0	2	2		*	
105	**Thymelaeaceae**							
515	*Edgeworthia gardneri*	S	+		+	++	***	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
106	**Urticaceae**							
516	*Boehmeria longifolia*	S	0	12	12	++	***	
517	*Boehmeria macrophylla*	S	7	27	34	++	***	
518	*Debregeasia sp.*	S	31	11	42		*	
519	*Elatostema lineolatum*	H	33	37	70		*	
520	*Elatostema platyphyllum*	H	+	+	+		*	
521	*Elatostema sessile*	H	23	69	92	++	***	
522	*Elatostema sikkimense*	S	+	+	+		*	
523	*Elatostemma sp.*	H		11	11		*	
524	*Girardinia diversifolia*	S	+	+	+	++	***	
525	*Laportea interrupta*	H	26	20	46		*	
526	*Oreocnide frutescens*	S	25	5	30		*	
527	*Oreocnide pedunculata*	S	+	+	+		*	
528	*Pilea cordifolia*	H	+	+	+		*	
529	*Pilea insolens*	H	10		10		*	
530	*Pilea scripta*	H	11	70	81	++	***	
531	*Poikilospermum lanceolatum*	C	6	42	48		*	
532	*Pouzolzia glaberrima*	S		3	3	++	***	
533	*Pouzolzia frondosa*	S	+	+	+		*	
534	*Pouzolzia fulgens*	H		7	7	++	***	
535	*Urtica dioica*	H	2	0	2		*	
107	**Verbenaceae**							
536	*Clerodendrum colebrookianum*	S	1	4	5	++	***	
537	*Gmelina arborea*	T				++	**	
538	*Pseudocaryopteris foetida*	S	+		+		*	
539	*Steptobion volubilis*	H	0	1	1		*	
108	**Violaceae**							
540	*Viola betonicifolia*	H				++	**	
541	*Viola diffusa*	H		3	3	++	***	
542	*Viola hediniana*	H				++	**	
543	*Viola flexuosa*	H	+	+	+		*	
544	*Viola inconspicua*	H	+	+	+		*	
545	*Viola moupinensis*	H	+	+	+		*	
546	*Viola thomsonii*	H	+	+	+		*	
547	*Viola Pilosa*	H	13	1	14		*	
109	**Vitaceae**							
548	*Cayratia mollissima*	C	+	+	+		*	
549	*Cayratia trifolia*	C		1	1		*	
550	*Tetrastigma affine*	C	64	70	134		*	

S. No.	Name	Life Form	Dri	Tangon	SAT	Others	CL	CS
551	*Tetrastigma dubium*	C	+		+		*	
552	*Tetrastigma obtectum*	C		+	+		*	
553	*Tetrastigma serrulatum*	C		+	+		*	
554	*Vitis sp.*	C	1		1		*	
555	*Vitis flexuosa*	C				++	**	
110	**Zingiberaceae**							
556	*Alpinia allughas*	H				++	**	
557	*Alpinia malaccensis*	H	9	17	26		*	
558	*Alpinia zerumbet*	H				++	**	
559	*Curcuma montana*	H				++	**	
560	*Globba clarkei*	H	12	24	36	++	***	
561	*Hedychium densiflorum*	H				++	**	
562	*Hedychium longipedunculatum*	H				++	**	
563	*Hedychium spicatum*	H	1	12	13	++	***	

*SAT=Study area total; SS = Secondary Source- Previous study (EIA 2015); Life Form: T – Tree, S- Shrub, C – Climber, H – Herb, G – Grass, B – Bamboo, Sg- Sedge, O – Orchid; CS= Conservation status (IUCN); CL=Cumulative locations; + = Reported in the present study; ++= Reported in previous study; *= Reported only from present study; **=Reported earlier; ***= Reported earlier and in present study.

Annexure 5.2: Gymnosperms reported/recorded in the Etalin HEP study area

S.No.	Name	Dri	Tangon	SAT	Others	CS	CL
1	**Cupressaceae**						
1	*Cupressus torulosa*				++		**
2	**Gnetaceae**						
2	*Gnetum montanum*		+	+	++		***
3	**Pinaceae**						
3	*Abies densa*				++		**
4	*Pinus wallichiana*				++		**
5	*Tsuga dumosa*				++		**
6	*Pinus merkusii*				++		**
4	**Taxaceae**						
7	*Cephalotaxus griffithii*				++		**
5	**Ephedraceae**						
8	*Ephedra aspera*	+		+			*

*SAT=Study area total; OT= Previous study; CS= Conservation status (IUCN); CL=Cumulative locations; + = Reported in the present study; ++= Reported in previous study; *= Reported only from present study; **=Reported earlier; ***= Reported earlier and in present study.

Annexure 5.3: Pteridophytes of Etalin HEP Study Area

S.No.	Name	Dri	Tangon	SAT	Others	CS	CL
1	**Adiantaceae**						
1	*Adiantum caudatum*				++		**
2	*Adiantum philippense*				++		**

S.No.	Name	Dri	Tangon	SAT	Others	CS	CL
2	**Angiopteridaceae**						
3	Angiopteris evecta				++		**
3	**Aspleniaceae**						
4	*Asplenium nidus*				++		**
4	**Cyatheaceae**						
5	*Cyathea gigantea*	0	2	2	++		***
6	*Cyathea spinulosa*	4	0	4	++		***
5	**Gleichiaceae**						
7	*Dicranopteris linearis*				++		**
6	**Athyriaceae**						
8	*Diplazium bentamense*				++		**
9	*Diplazium sp.*	0	8	8			*
7	**Polypodiaceae**						
10	*Drymoglossum heterophyllum*				++		**
11	*Dryoathyrium boryanum*				++		**
8	**Equisetaceae**						
12	*Equisetum ramossimum*	5	4	9	++		***
9	**Polypodiaceae**						
13	*Arthromeris wallichiana*				++		**
14	*Lepisorus excavata*	0	2	2	++		***
15	*Lepisorus sordidus*	12	3	15	++		***
16	*Lepisorus nudus*				++		**
17	*Microsorum punctctum*				++		**
18	*Microsorum pteropus*				++		**
19	*Polypodium amoenum*				++		**
20	*Phymatopteris ebenipes*	+		+			*
21	*Phymatosorus cuspidatus*		+	+			*
10	**Lycopodiaceae**						
22	*Lycopodium clavatum*				++		**
11	**Nephrolepdaceae**						
23	*Nephrolepis cordifolia*				++		**
24	*Nephrolepis auriculata*	15	0	15			*
12	**Aspidiaceae**						
25	*Polystichum aculeatum*	5	0	5	++		***
13	**Thelypteridaceae**						
26	*Pronephrium affine*				++		**
14	**Dennstaedtiaceae**						
27	*Pteridium aquilinum*	4	0	4	++		***
15	**Pteridaceae**						
28	*Pteris quadriaurita*				++		**
29	*Pteris vittata*				++		**
30	*Onychium siliculosum*		+	+	++		***
16	**Selaginellaceae**						

S.No.	Name	Dri	Tangon	SAT	Others	CS	CL
31	*Selaginella* sp.	0	5	5	++		***

*SAT=Study area total; OT= Previous study; CS= Conservation status (IUCN); CL=Cumulative locations; + = Reported in the present study; ++= Reported in previous study; *= Reported only from present study; **=Reported earlier; ***= Reported earlier and in present study.

Annexure 5.4: List of Butterfly species recorded in Etalin HEP Project Study Area

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
	Family: Hesperiidae							
1	*Caltoris kumara*	Blank Swift	-	-	-	+	**	
2	*Ctenoptilum vasava vasava Moore, 1865*	Tawny Angle	+	-	+	-	*	
3	*Hasora chromus chromus Vramer, 1780*	Common Banded Awl	+	+	+	-	*	
4	*Hasora vitta indica Evans, 1932*	Plain Banded Awl	+	+	+	-	*	
5	*Notocrypta curvifascia curvifascia Felder and Felder, 1862*	Restricted Demon	+	+	+	-	*	
6	*Notocrypta curvifascia curvifascia Felder and Felder, 1862*	Paint Brush Swift	-	+	+	-	*	
7	*Notocrypta feisthamelii alysos Moore, 1865*	Himalayan Spotted Demon	+	+	+	-	*	
8	*Notocrypta paralysos asawa Fruhstorfer, 1911*	Indo Chinese Common Banded Demon	-	+	+	-	*	
9	*Tagiades cohaerens cynthia Evans, 1934*	Himalayan White-Striped Snow Flat	+	+	+	-	*	
10	*Taractrocera maevius*	Common Grass Dart	-	-	-	+	**	
	Family: Lycaenidae							
11	*Acytolepis puspa gisca Fruhstorfer, 1910*	Common Hedge Blue	+	+	+	+	***	
12	*Arhopala centaurus*	Centaur Oakblue	-	-	-	+	**	
13	*Caleta caleta decidia*	Angled Pierrot	-	-	-	+	**	
14	*Catochrysops strabo strabo Fabricius, 1793*	Oriental Forgetmenot	+	+	+	-	*	
15	*Celastrina argiolus kollari Westwood, 1852*	West Himalayan Hill Hedge Blue	+	+	+	-	*	
16	*Chliaria kina kina Hewitson, 1869*	Blue Tit	+	+	+	-	*	
17	*Curetis acuta dentata Moore, 1879*	Angled Sunbeam	+	+	+	-	*	
18	*Curetis bulis bulis Westwood, 1851*	Bright Sunbeam	+	+	+	-	*	
19	*Curetis thetis (Drury, [1773])*	Indian Sunbeam	+		+	-	*	
20	*Heliophorus brahma Moore, 1857*	Golden Sapphire	+	+	+	-	*	
21	*Heliophorus epicles indicus*	Purple Sapphire	-	-	-	+	**	
22	*Heliophorus epicles latilimbata Fruhstorfer, 1908*	Eastern Purple Sapphire	+	+	+	-	*	
23	*Heliophorus indicus Fruhstorfer, 1908*	Dark Sapphire	+	+	+	-	*	

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
24	*Heliophorus moorei tytleri Riley, 1929*	Naga Azure Sapphire	+	-	+	-	*	
25	*Heliophorus oda Hewitson, 1865*	Eastern Blue Sapphire	+	+	+	-	*	
26	*Heliophorus tamu Kollar, 1844*	Himalayan Powdery Green Sapphire	+	+	+	-	*	
27	*Jamides bochus bochus Stoll, 1782*	Dark Cerulean	+	+	+	+	***	
28	*Jamides caeruleus caeruleus Druce, 1873*	Oriental Royal Cerulean	+	-	+	-	*	
29	*Jamides celeno Cramer, 1775*	Common Cerulean	+	+	+	+	***	
30	*Lampides boeticus Linnaeus, 1767*	Peablue	+	+	+	+	***	
31	*Lampides kankena*	Glistening cerulean	-	-	-	+	**	
32	*Loxura atymnus continentalis Fruhstorfer, 1912*	Yamfly	+	+	+	-	*	
33	*Lycaena phlaeas*	Small Copper	-	-	-	+	**	
34	*Nacaduba beroe gythion Fruhstorfer, 1916*	Six Lineblue	+	-	+	-	*	
35	*Nacaduba dubiosa indica Evans, 1925*	Tailless Lineblue	+	-	+	-	*	
36	*Nacaduba helicon*	Pointed Lineblue	-	-	-	+	**	
37	*Neptis hylas varmona Moore, 1872*	Common Sailer	+	+	+	+	***	
38	*Orthomiella pontis pontis Elwes, 1887*	Straightwing Blue	+	+	+	-	*	
39	*Prosotas nora ardates Moore, 1874*	Common Lineblue	+	+	+	-	*	
40	*Pseudozizeeria maha maha Kollar, 1844*	Pale Grass Blue	+	+	+	-	*	
41	*Rapala maena schistacea Moore, 1879*	Slate Flash	+	-	+	-	*	
42	*Rapala nissa ranta Swinhoe, 1897*	Jaintia Common Flash	+	-	+	-	*	
43	*Rapala pheretima petosiris Hewitson, 1863*	Indian Copper Flash	+	-	+	-	*	
44	*Symbrenthia hypselis cotanda Moore, 1874*	Spotted Jester	+	+	+	-	*	
45	*Symbrenthia lilaea khasiana Moore, 1874*	Common Jester	+	+	+	-	*	
46	*Tarucus Ananda*	Dark Pierrot	-	-	-	+	**	
47	*Udara albocaeruleus albocaeruleus Moore, 1879*	Himalayan Albocerulean	+	+	+	+	***	
48	*Udara dilecta dilecta Moore, 1879*	Pale Hedge Blue	+	-	+	+	***	
49	*Yasoda tripunctata tripunctata Hewitson, 1863*	Branded Yamfly	+	+	+	-	*	
50	*Zizina otis otis Fabricius, 1787*	Lesser Grass Blue	-	+	+	-	*	
	Family: Nymphalidae							
51	*Aglais cashmirensis aesis Fruhstorfer, 1912*	Indian Tortoiseshell	+	+	+	-	*	

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
52	*Apatura ambica ambica Kollar, 1844*	Indian Purple Emperor	+	+	+	-	*	
53	*Argynnis hyperbius hyperbius Linnaeus, 1763*	Indian Fritillery	+	+	+	+	***	
54	*Athyma cama cama Moore, 1857*	Orange Staff Sergeant	+	+	+	-	*	
55	*Athyma orientalis Elwes, 1888*	Elongated Sergeant	+	+	+	-	*	
56	*Athyma perius perius* Linnaeus, 1758	Common Sergeant	+	+	+	-	*	
57	*Athyma zeroca zeroca Moore, 1872*	Khasi Small Staff Sergeant	+	+	+	-	*	
58	*Auzakia danava Moore, 1857*	Indian Commodore	+	+	+	-	*	
59	*Calinaga sp.*	Freak	+	+	+	-	*	
60	*Callerebia narasingha narasingha Moore, 1857*	Himalayan Mottled Argus	+	-	+	-	*	
61	*Cethosia biblis tisamena Fruhstorfer, 1912*	Himalayan Lacewing	+	+	+	-	*	
62	*Charaxes dolon dolon Westwood, 1848*	Himalayan Stately Nawab	+	+	+	-	*	
63	*Charaxes eudamippus eudamippus Doubleday, 1843*	Great Nawab	+	+	+	-	*	
64	*Charaxes moori Distant, 1883*	Malayan Nawab	-	+	+	-	*	
65	*Cirrochroa aoris aoris Doubleday, 1847*	Large Yeoman	+	-	+	+	***	
66	*Cirrochroa tyche mithila Moore, 1872*	Common Yeoman	+	+	+	-	*	
67	*Cyretis thyodamas thyodamas Boisduval, 1836*	Common Map	+	+	+	+	***	
68	*Elymnias malelas malelas Hewitson, 1863*	Spotted Palmfly	+	+	+	-	*	
69	*Elymnias vasudeva Moore, 1857*	Jezebel Palmfly	-	+	+	-	*	
70	*Euploea core core Cramer, 1780*	Indian Common Crow	+	+	+	-	*	
71	*Euploea crameri nicevillei*	Spotted Black Crow	+	+	+	-	*	Sch 1 Part 4
72	*Euploea midamus rogenhoferi Felder and Felder, 1865*	Spotted Blue Crow	+	+	+	-	*	
73	*Euploea mulciber mulciber Cramer, 1777*	Striped Blue Crow	+	+	+	-	*	
74	*Euploea sylvester hopei Felder and Felder, 1865*	Double Banded Crow	+	-	+	-	*	
75	*Euploea tulliolus*	Dwarf Crow	-	-	-	+	**	
76	*Euthalia franciae franciae Gray, 1846*	French Duke	+	+	+	-	*	
77	*Euthalia phemius phemius Doubleday, 1848*	Sylhet White-Edged Blue Baron	+	+	+	-	*	
78	*Herona marathus marathus Doubleday, 1848*	Pasha	+		+	-	*	
79	*Hestina persimilis*	Siren	-	-	-	+	**	
80	*Hestinalis nama nama Doubleday, 1844*	Circe	+	+	+	+	***	

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
81	*Junonia iphita iphita Cramer, 1779*	Chocolate Pansy	+	+	+	-	*	
82	*Junonia oithya Linnaeus, 1758*	Blue Pansy	+	-	+	-	*	
83	*Kallima inachus inachus Boisduval, 1836*	Orange Oakleaf	+	+	+	+	***	
84	*Kaniska canace canace Linnaeus, 1763*	Blue Admiral	+	+	+	-	*	
85	*Lethe confusa confusa Aurivillius, 1898*	Banded Treebrown	+	+	+	-	*	
86	*Lethe mekara mekara Moore, 1857*	Common Red Forester	+	-	+	-	*	
87	*Lethe rohria rohria Fabricius, 1787*	Common Treebrown	+	+	+	-	*	
88	*Libythea lepitalepita Moore, 1857*	Common Beak	+	+	+	-	*	
89	*Libythea myrrha sanguinalis Fruhstorfer, 1898*	Ochreous Club Beak	+	+	+	+	***	
90	*Mycalesis francisca albofasciata Tytler, 1914*	Manipur Lilacine Bush Brown	+	+	+	-	*	
91	*Neptis mahendra mahendra Moore, 1872*	West Himalayan Sailer	+	-	+	-	*	
92	*Neptis miah miah Moore, 1857*	East Himalayan Small Yellow Sailer	-	+	+	-	*	
93	*Neptis namba namba Tytler, 1915*	Namba Sailer	+	+	+	-	*	
94	*Neptis pseudovikasi Moore, 1899*	False Dingy Sailor	-	+	+	-	*	
95	*Neptis sankara amba Moore, 1858*	Broad Banded Sailer	+	+	+	-	*	
96	*Neptis sappho astola Moore, 1872*	Himalayan Rusty Sailer/Pallas's Sailer	-	+	+	-	*	
97	*Neptis soma soma Moore, 1858*	Creamy Sailer	+	+	+	-	*	
98	*Pantoporia hordonia hordonia Stoll, 1790*	Common Lascar	-	+	+	-	*	
99	*Papilio helenus helenus Linnaeus, 1758*	Red Helen	+	+	+	-	*	
100	*Papilio paris paris Linnaeus, 1758*	Paris Peacock	+	+	+	+	***	
101	*Papilio polytes romulus Cramer, 1775*	Common Mormon	+	+	+	-	*	
102	*Parantica aglea melanoides Moore, 1883*	Glassy Tiger	+	+	+	-	*	
103	*Parantica agleoides*	Dark- glassy Tiger	-	-	-	+	**	
104	*Parantica melaneus plataniston Fruhstorfer, 1910*	Chocolate Tiger	+	+	+	-	*	
105	*Parantica sita sita Kollar, 1844*	Himalayan Chestnut Tiger	+	+	+	-	*	
106	*Parasarpa dudu dudu Westwood, 1850*	White Commodore	+	+	+	-	*	
107	*Precis hierta*	Yellow Pansy	-	-	-	+	**	
108	*Precis iphita iphita*	Chocolate Soldier	-	-	-	+	**	
109	*Precis lemonias*	Lemon Pansy	-	-	-	+	**	

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
110	*Pseudergolis wedah wedah Kollar, 1844*	Tabby	+	+	+	-	*	
111	*Rohana parisatis parisatis Westwood, 1850*	Black Prince	+	+	+	+	***	
112	*Stibochiona nicea nicea Gray, 1846*	Popinjay	+	+	+	-	*	
113	*Sumalia daraxa daraxa Doubleday, 1848*	Green Commodore	+	+	+	-	*	
114	*Symbrenthia niphanda niphanda Moore, 1872*	Bluetail Jester	+	+	+	-	*	
115	*Symbrenthia silana de Nicéville, 1885*	Scarce Jester	+	+	+	-	*	Sch 1 Part 4
116	*Tirumala septentrionis septentrionis Fruhstorfer, 1899*	Oriental Dark Blue Tiger	+	+	+	-	*	
117	*Vanessa cardui Linnaeus, 1758*	Painted Lady	+	+	+	-	*	
118	*Vanessa indica indica Herbst, 1794*	Indian Red Admiral	+	+	+	-	*	
119	*Ypthima asterope mahratta Moore, 1884*	Common Threering	+	-	+	+	***	
120	*Ypthima hubneri Kirby, 1871*	Common Fourring	+	-	+	-	*	
121	*Ypthima newara*	Large Three-Ring	-	-	-	+	**	
122	*Ypthima sakra sakra Moore, 1857*	Himalayan Fivering	+	+	+	-	*	
	Family: Papilionidae							
123	*Appias lalage lalage Doubleday, 1842*	Spot Puffin	+	+	+	-	*	
124	*Atrophaneura varuna astorion Westwood, 1842*	Common Batwing	+	+	+	-	*	
125	*Byasa dasarada dasarada Moore, 1857*	Great Windmill	+	-	+	-	*	
126	*Byasa polyeuctes polyeuctes Doubleday, 1842*	Common Windmill	+	+	+	-	*	
127	*Catopsilia pomona crocale Fabricius, 1775*	Common Emigrant	+	+	+	-	*	
128	*Colias fieldii fieldii Menetries, 1855*	Dark Clouded Yellow	+	-	+	-	*	
129	*Gandaca harina assamica Moore, 1906*	Tree Yellow	+	+	+	-	*	
130	*Gonepteryx rhamni nepalensis Doubleday, 1847*	Himalayan Brimstone	+	-	+	-	*	
131	*Graphium agetes agetes Westwood, 1843*	Fourbar Swordtail	+	+	+	+	***	
132	*Graphium antiphates pompilius Fabricius, 1787*	Fivebar Swordtail	+	+	+	-	*	
133	*Graphium chironides chironides Honrath, 1884*	Veined Jay	+	-	+	-	*	
134	*Graphium cloanthus cloanthus Westwood, 1841*	Glassy Bluebottle	+	+	+	-	*	
135	*Graphium doson axion Felder and Felder, 1864*	Common Jay	+	-	+	-	*	
136	*Graphium eurous sikkimica*	East Himalayan Six Bar	+	+	+	-	*	

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
	Heron, 1899	Swordtail						
137	*Graphium macareus indicus Rothschild, 1895*	Lesser Zebra	+	+	+	-	*	
138	*Graphium megarus megarus Westwood, 1844*	Assam Spotted Zebra	+	+	+	-	*	
139	*Graphium sarpedon sarpedon Linnaeus, 1758*	Common Bluebottle	+	+	+	+	***	
140	*Lamproptera curius curius Fabricius, 1787*	White Dragontail	+	+	+	-	*	
141	*Lamproptera meges indistincta Tytler, 192*	Green Dragontail	+	+	+	-	*	
142	*Papilio agestor agestor Gray, 1831*	Tawny Mime	+	+	+	-	*	
143	*Papilio alcmenor alcmenor C and R Felder, 1864*	Redbreast	+	-	+	+	***	
144	*Papilio crino Fabricius, 1793*	Common Banded Peacock	+	-	+	-	*	
145	*Papilio epycides Hewitson, 1862*	Lesser Mime	+	+	+	-	*	
146	*Papilio memnon agenor Linnaeus, 1758*	Great Mormon	+	+	+	+	***	
147	*Papilio nephelus chaon Westwod, 1845*	Yellow Helen	+	-	+	-	*	
148	*Papilio protenor euprotenor Fruhstorfer, 1908*	Himalayan Spangle	+	-	+	-	*	
149	*Pieris brassicae nepalensis Doubleday, 1846*	Large Cabbage White	-	+	+	-	*	
150	*Pieris canidia indica Evans, 1926*	Indian Cabbage White	+	+	+	+	***	
151	*Prioneris thestylis thestylis Doubleday, 1842*	Spotted Sawtooth	+	-	+	+	***	
152	*Troides aeacus aeacus Felder and Felder, 1860*	Golden Birdwing	+	-	+	-	*	
153	*Troides helena cerberus Felder and Felder, 1865*	Common Birdwing	+	+	+	-	*	
	Family: Pieridae							
154	*Abisara neophron neophron Hewitson, 1861*	Tailed Judy	+	+	+	-	*	
155	*Appias albina darada Felder & Felder, 1865*	Sylhet Common Albatross	+	+	+	-	*	
156	*Appias indra indra Moore, 1857*	Plain Puffin	+	+	+	-	*	
157	*Appias lyncida eleonora Boisduval, 1836*	Indo Chinese Chocolate Albatross	+	+	+	-	*	
158	*Catopsilia pyranthe pyranthe Linnaeus, 1758*	Mottled Emigrant	+	-	+	+	***	
159	*Delias acalis pyramus Wallace, 1867*	Red Breast Jezebel	+	+	+	+	***	
160	*Cepora nadina nadina Lucas, 1852*	Lesser Gull	+	+	+	-	*	
161	*Delias belladonna ithiela Butler, 1869*	Hill Jezebel	+	+	+	-	*	
162	*Delias descombesi*	Redspot Jezebel	-	-	-	+	**	

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area	SS	CL	WPA Status
163	*Delias hyparete*	Painted Jezebel	-	-	-	+	**	
164	*Delias samaca Moore, 1857*	Pale Jezebel	+	+	+		*	Sch 1 Part 4
165	*Dercas lycoris lycoris*	Plain Sulphur	-	-	-	+	**	
166	*Dercas verhuelli doubledayi Moore, 1905*	Tailed Sulphur	+		+	-	*	
167	*Dodona adonira adonira Hewitson, 1865*	Striped Punch	+	+	+	-	*	
168	*Dodona dipoea dipoea Hewitson, 1865*	Lesser Punch	+	+	+	-	*	
169	*Eurema andersonii Moore, 1886*	Sikkim One-Spot Grass Yellow	+		+	-	*	
170	*Ixias pyrene*	Yellow Orangetip	-	-	-	+	**	
171	*Pareronia hippia Fabricius, 1787*	Common Wanderer	+	+	+	-	*	
172	*Pareronia sp*	Dark Wanderer	-	+	+	-	*	
173	*Pieris rapae meleager Hemming, 1934*	Small Cabbage White	-	+	+	-	*	
	Family: Riodinidae							
174	*Abisara fylla Westwood, 1851*	Dark Judy	+	+	+	-	*	
175	*Dodona durga durga Kollar, 1844*	Common Punch	+	+	+	-	*	
176	*Dodona eugenes venox Fruhstorfer, 1912*	Tailed Punch	+	+	+	-	*	
177	*Dodona ouida phlegra Fruhstorfer, 1914*	West Himalayan Mixed Punch	+	+	+	-	*	
178	*Stiboges nymphidia nymphidia Butler, 1876*	Malayan Columbine	+	+	+	-	*	
179	*Zemeros flegyas flegyas Cramer, 1780*	Punchinello	+	+	+	+	***	

SS – Secondary Source (EIA Study 2016); CL – Cumulative List : * Species recorded only during this study, ** species reported exclusively from SS, *** Species common to both present study and secondary source, WPA 1072 – Wildlife Protection Act : Schedule I - IV

Annexure 5.5: List of Odonate species recorded in Etalin HEP Project Study Area

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area
	Family: Libellulidae				
1	*Orthetrum triangulare* Selys, 1878	Blue-Tailed Forest Hawk	*	*	*
2	*Crocothemis servilia* Drury, 1770	Scarlet Skimmer	*		*
3	*Orthetrum glaucum* Brauer, 1865	Blue Marsh Hawk	*	*	*
4	*Orthetrum pruinosum* Burmeister, 1839	Crimson-tailed Marsh Hawk	*	*	*
5	*Orthetrum taeniolatum* Schneider, 1845	Taeniolate Marsh Hawk	*		*
6	*Trithemis festiva* Rambur, 1842	Black Stream Glider	*	*	*
7	*Pantala flavescens* Fabricius, 1798	Wandering glider	*		*
8	*Orthetrum chrysis* Selys, 1891	Brown Backed Marsh Hawk	*		*
9	*Orthetrum sabina* Drury, 1770	Green marsh hawk	*	*	*
	Family: Calicnemiinae				

S. No.	Scientific Name	Common Name	Dri	Tangon	Study Area
10	*Calicnemia miniata* Selys, 1886		*		*
11	*Calicnemia sp 2*		*		*

Annexure 5.6: List of Spider species recorded in Etalin HEP Project Study Area

S. No.	Family / Genus	Species	Dri	Tangon	Study Area
	Agaelenidae C. L. Koch, 1837				
1	*Tamgrinia*	*sp 1*	*	*	*
2	*Tegenaria*	*sp1*	*	*	*
	Araneidae Clerck, 1757				
3	*Larinia*	*sp 1*		*	*
4	*Herennia*	*punctata*	*		*
5	*Cyrtophora*	*citricola*	*	*	*
6		*unicolor*	*		*
7	*Neoscona*	*sp 1*	*	*	*
8	*Plebs*	*himalayensis*	*	*	*
9	*Araneus*	*mitificus*	*	*	*
10		*multipunctata*	*	*	*
11	*Gasteracantha*	*unguifera*	*		*
12	*Cyclosa*	*sp 1*	*	*	*
13		*hexatuberculata*	*		*
14		*spirifera*	*	*	*
15		*fissicanda*		*	*
16	*Argiope*	*catenulata*	*		*
17		*aemula*	*	*	*
18		*pulchella*		*	*
19		*sp 1*		*	*
20	*Anepsion*	*sp 1*	*		*
21	*Gea*	*spinipes*	*	*	*
22	*Chorizopes*	*bengalensis*		*	*
23		*sp 1*		*	*
24	*Eriovixia*	*excelsa*	*		*
25		*laglaizei*		*	*
26	*Thelacantha*	*bravispina*	*	*	*
27	*Zygiella*	*sp 1*		*	*
	Clubionidae Wagner, 1887				
28	*Clubiona*	*shillonghensis*		*	*
29		*filicata*	*		*
30		*hysgina*		*	*
	Corrinidae Karsch, 1880				
31	*Cambalida*	*sp 1*	*		*
32	*Orthobula*	*sp 1*		*	*
33	*Castianeira*	*zeta*		*	*
	Eutrichuridae Lehtinen, 1967				
34	*Chericanthium*	*sp 1*	*	*	*
35	*Gen 1*	*sp 1*		*	*

S. No.	Family / Genus	Species	Dri	Tangon	Study Area
	Filistatidae Ausserer, 1867				
36	*Pritha*	*sp 1*	*	*	*
	Gnaphosidae Pocock, 1898				
37	*Zelotes*	*sp 1*		*	*
	Hahniidae Bertkau, 1878				
38	*Hahnius*	*sp 1*	*	*	*
	Hersiliidae Thorell, 1870				
39	*Hersilia*	*sp 1*	*	*	*
	Linyphiidae Blackwall, 1859				
40	*Linyphia*	*triangularis*	*	*	*
41	*Plectembolus*	*sp 1*	*	*	*
42		*sp 2*	*	*	*
43	*Neriene*	*sp 1*	*	*	*
44	*Lepthyphantes*	*sp 1*	*	*	*
	Liocranidae Simon, 1897				
45	*Gen 1*	*sp 1*		*	*
	Lycosidae Sundevall, 1833				
46	*Lycosa*	*himalayensis*	*	*	*
47	*Pardosa*	*sumatrana*	*	*	*
48		*birmanica*	*	*	*
	Mimetidae Simon, 1881				
49	*Mimetus*	*sp 1*	*	*	*
	Miturgidae Simon, 1886				
50	*Gen 1*	*sp 1*		*	*
	Oonopidae Simon, 1890				
51	*Gen 1*	*sp 1*	*		*
	Oxyopidae Thorell, 1870				
52	*Oxyopes*	*sp 1*	*	*	*
	Pholcidae C. L. Koch, 1850				
53	*Pholcus*	*affinis CNF.*		*	*
54	*Artema*	*sp 1*	*	*	*
	Pisauridae Simon, 1890				
55	*Dendrolycosa*	*sp 1*	*	*	*
	Psechridae Simon, 1890				
56	*Psechrus*	*sp 1*	*	*	*
	Salticidae Blackwall, 1841				
57	*Phintella*	*sp 1*	*	*	*
58	*Plexippus*	*paykulli*	*	*	*
59		*sp 1*	*	*	*
60	*Yaginumaella*	*sp 1*		*	*
61	*Carrhotus*	*sp 1*	*	*	*
62	*Thiania*	*sp 1*	*	*	*
63	*Telamonia*	*sp 1*		*	*
64	*Asemonea*	*tenuipes*	*	*	*
65	*Chrysilla*	*sp1*		*	*
66	*Rhene*	*albigena*		*	*

S. No.	Family / Genus	Species	Dri	Tangon	Study Area
67	*Aerullius*	*sp 1*		*	*
68	*Hyllus*	*semicupreus*	*	*	*
69		*sp 1*		*	*
70	*Pristobaeus*	*sp 1*		*	*
71	*Siler*	*semiglaucus*		*	*
72		*sp 1*		*	*
73	*Brettus*	*sp 1*		*	*
74	*Menemerus*	*sp 1*	*		*
75		*natalis CNF*	*		*
76	*Portia*	*fimbriata*			*
77		*sp1*		*	*
78	*Thyene*	*sp 1*			*
79	*Myrmarachne*	*sp 1*	*		*
80	*Epocilla*	*sp 1*		*	*
	Sparassidae Bertkau, 1872				
81	*Bhutaniella*	*kronestedti*	*		*
82	*Olios*	*sp 1*	*	*	*
83		*sp 2*	*		*
84	*Heteropoda*	*sp 1*	*	*	*
85		*promota*		*	*
	Tetragnathidae Menge, 1866				
86	*Leucauge*	*sp 1*		*	*
87		*celebesiana*	*	*	*
88		*decorata*	*	*	*
89	*Mesida*	*culta*	*	*	*
90	*Tetragnatha*	*sp 1*	*	*	*
91	*Opademeta*	*sp 1*		*	*
	Theridiidae Sundevall, 1833				
92	*Phoroncidia*	*Sp 1*		*	*
93	*Episinus CNF*	*sp 1*	*		*
94	*Theridion*	*sp 1*	*	*	*
95	*Meotipa*	*sp 1*		*	*
96	*Theridula*	*sp 1*	*		*
97	*Thwaitsia*	*sp 1*	*	*	*
98		*sp 2*		*	*
99	*Parasteatoda*	*sp 1*		*	*
100	*Achaeranea*	*sp 1*		*	*
	Thomisidae Sundevall, 1833				
101	*Ozyptila*	*khasi*		*	*
102	*Misumenops*	*sp 1*	*	*	*
103	*Dieta*	*sp 1*			*
104	*Xysticus*	*croceus*	*	*	*
105	*Camaricus*	*sp 1*	*	*	*
106	*Misumena*	*sp 1*		*	*
107	*Indoxysticus*	*sp 1*	*	*	*

S. No.	Family / Genus	Species	Dri	Tangon	Study Area
108	*Oxytate*	*sp 1*		*	*
109	*Thomisus*	*sp 1*		*	*
110	*Synema*	*decoratum*	*		*
	Uloboridae Thorell, 1869				
111	*Uloborus*	*krishnae*	*		*
112		*sp 1*	*		*
113	*Miagrammopes*	*sp 1*	*	*	*

Annexure 5.7: List of Moth Species recorded from Base Camp

S. No.	Scientific Name	Common Name
	Brahmaeidae	
1	*Brahmaea hearseyi* White, 1862	Pale Brahmid Moth
	Drepanidae	-
2	*Macrocilix maia* (Leech, 1888)	-
3	*Callidrepana patrana* (Moore, [1866])	-
	Erebidae	
4	*Nyctemera arctata* Walker, 1856	-
5	*Areas galactina orientalis*	-
6	*Cyana puer* (Elwes, 1890)	-
7	*Lymantria concolor*	-
8	*Gen 1*	-
9	*Eudocima sp 1*	-
10	*Euproctis sp1*	-
11	*Gen sp 2*	-
12	*Spilosoma sp.*	-
	Geometridae	
13	*Hypomecis transcissa* (Walker, 1860)	-
14	*Dysphania militaris* Linnaeus, 1758	-
15	*Antipercnia belluaria* (Guenée, [1858])	-
16	*Comostola laesaria* (Walker, 1861)	-
17	*Hypomecis cineracea* (Moore, 1888)	-
18	*Percnia felinaria* Guenée, 1857	-
19	*Thalassodes* sp1	-
20	*Vindusara* sp 1	-
21	*Thallasodes* sp2	-
22	*Hypomecis* sp1	-
23	*Cleora* sp1	-
24	*Sirinopteryx rufivinctata* Walker, 1862	-
25	*Chiasmia sp1*	-
26	*Abraxas sp 1*	-
27	*Biston sp1*	-
28	*Dalima lucens CF.*	-
29	*Alcis sp.*	-
30	*Comostola sp.*	-
31	*Krananda sp.*	-
32	*Scopula sp.*	-
33	*Xandrames sp.*	-
	Lasiocampidae	
34	*Trabala vishnou* (Lefèbvre, 1827)	Vishnu Lappet Moth; Rose Myrtle Lappet Moth

S. No.	Scientific Name	Common Name
	Saturniidae	-
35	*Actias parasinensis* Brechlin, 2009	Western Chinese Moon Moth
36	*Samia canningii* (Hutton, 1860)	Wild Eri Silk Moth
37	*Saturnia anna* Moore, [1865]	Yellow-spotted Emperor Moth
38	*Actias selene* (Hübner, [1807])	Indian Moon Moth
39	*Loepa sp.*	-
40	*Antheraea mylitta* (Drury, 1773)	-
	Uraniidae	
41	*Lyssa zampa* (Butler, 1869)	Giant Uraniid Swallowtail
42	*Pseudomicronia advocataria* (Walker, 1861)	-
	Zygaenidae	
43	*Corma maculata* Hampson, 1892	-
	Crambidae	
44	Endocrossis flavibasalis (Moore, 1867)	-
45	Cotachena pubescens	-
	Eupterotidae	
46	*Eupterote pandya* (Moore, [1866])	-
	Noctuidae	
47	*Episteme sp.*	-
	Sphingidae	
48	*Cechetra lineosa* (Walker, 1856)	Striped Green Hawkmoth
49	*Cechetra scotti* (Rothschild, 1920)	Scott's Green Hawkmoth
50	*Eupanacra sinuate*	-
51	*Theretra sp.*	-

Annexure 5.8: List of Amphibians and Reptiles recorded in the Etalin HEP Study Area

S.No	Family / Scientific Name	Groups/ Common Name	Dri	Tangon	SAT	CS
A	**AMPHIBIANS**					
1	**Bufonidae**	**Toads**				
1	*Duttaphrynus melanostictus*	Common Asian Toad	*	*	*	LC
2	*Duttaphrynus* cf. *stuarti*	Stuart's Toad		*	*	DD
2	**Dicroglossidae**	**Aquatic Frog**				
3	*Euyphlyctis cyanophlytis*	Indian Skipping Frog	*	*	*	DD
4	*Hoplobatrachus tigerinus*	Indian Bull Frog	*		*	LC
5	*Hoplobatrachus crassus*	Jerdon's Bull Frog	*		*	LC
6	*Occidozyga borealis*	Northern Trickle Frog	*	*	*	
3	**Megophryidae**	**Horned Frog**				
7	*Megophrys* cf. *major*	Asian Horned Frog	*		*	LC
4	**Ranidae**	**Ranid Frog**				
8	*Amolops assamensis*	Assamese Cascade Frog		*	*	DD
9	*Clinotarsus alticola*	Point-nose Frog	*	*	*	LC
5	**Rhacophoridae**	**Tree Frog**				
10	*Raorchestes* sp	Bush Frog		*	*	
11	*Feihyhyla vittatus*	Two striped pigmy tree Frog	*		*	LC
12	*Polypedates teraiensis*	Common Tree Frog	*	*	*	
13	*Rhacophorus maximus*	Large Tree Frog	*	*	*	LC
6	**Microhylidae**	**Pigmy Frog**				
14	*Microhyla berdmorei*	Burmese pigmy frog		*	*	LC
B	**REPTILES**					
1	**Agamidae**	**Agamid Lizards**				
1	*Calotes jerdoni*	Jerdon's Forest Calotes	*		*	

S.No	Family / Scientific Name	Groups/ Common Name	Dri	Tangon	SAT	CS
2	*Japalura cf. andersoniana*	Mountain Lizard	*	*	*	
2	**Scincidae**	**Skinks**				
3	*Eutropis macularia*	Bronze Grass Skink	*	*	*	
4	*Eutropis multifasciata*	Many-lined Grass Skink	*	*	*	
5	*Asymblepharus* sp.		*	*	*	
6	*Sphenomorphus indicus*	Himalayan Litter Skink	*	*	*	
7	*Sphenomorphus maculatus*	Spotted Litter Skink		*	*	
3	**Varanidae**	**Monitor Lizard**				
8	Varanus bengalensis	Bengal Monitor Lizard	*		*	LC/ Sch-I
4	**Boidae**	**Python**				
9	*Python bivittatus*	Burmese Python	*	*	*	VU/ Sch-I
5	**Colubridae**	**Non-Venomous Snakes**				
10	*Pareas monticola*	Assam Snail Eater	*	*	*	
11	*Gonyosoma frenatum*	Green Trinket Snake	*		*	
12	*Orthriophis taeniura yunannanensis*	Striped Trinket Snake / Yunnan Striped Trinket Snake	*	*	*	
13	*Coelognathus radiatus*	Copper-headed Trinket Snake	*		*	LC
14	*Oligodon albocinctus*	White-barred Kukri Snake	*	*	*	
15	*Dendrelaphis proarchos*	Painted bronzeback	*	*	*	
16	*Lycodon laoensis*	Laotian Wolf Snake	*		*	
17	*Lycodon aulicus*	Common Wolf Snake		*	*	
18	*Ptyas korros*	Indo Chinese Rat Snake	*	*	*	
19	*Ptyas nigromarginata*	Green Rat Snake		*	*	
20	*Rhabdophis himalayanus*	Himalayan Keelback	*	*	*	
21	*Rhabdops bicolor*	Bicolor Snake	*		*	
22	*Pseudoxenodon macrops*	False Cobra	*	*	*	LC
23	*Boiga cyanea*	Green Cat Snake		*	*	
24	*Boiga gokool*	Eastern Cat Snake	*	*	*	
25	*Boiga siamensis*	Siamese cat snake	*		*	
26	*Psammodynastes pulverulentus*	Mock Viper	*	*	*	
6	**Elapidae**	**Venomous Snakes**				
27	*Bungarus fasciatus*	Banded Krait	*	*	*	LC
28	*Bungarus niger*	Black Krait	*		*	
29	*Naja kaouthia*	Monocled cobra	*	*	*	LC
30	*Ophiophagus hannah*	King Cobra		*	*	VU
7	**Viperidae**					
31	*Popeia popeiorum*	Popes pit viper	*	*	*	LC

Annexure 5.9: List of Birds recorded and reported as part of Etalin HEP Study Area

S.No	Family/Scientific Name	English Name	MS	FG	DR	TR	C	SA	CL	CS
1	**Accipitridae**									
1	*Gyps himalayensis*	Himalayan Vulture	SV	C		1		1	*	
2	*Milvus migrans*	Black Kite	R	C		1		1	*	
3	*Pernis ptilorhynchus*	Oriental Honey Buzzard	SV	C		1		1	*	
4	*Spilornis cheela*	Crested Serpent Eagle	R	C	7	6		13	***	
5	*Ictinaetus malaiensis*	Black Eagle	R	C	5			5	*	

S.No	Family/Scientific Name	English Name	MS	FG	DR	TR	C	SA	CL	CS
6	*Aquila fasciata*	Bonelli's Eagle	SV	C		1		1	*	
7	*Hieraaetus pennatus*	Booted Eagle	SV	C		1		1	*	
8	*Accipiter trivirgatus*	Crested Goshawk	SV	C		1		1	*	Sch-I
9	*Accipiter badius*	Shikra	WV	C		2	2	4	*	Sch-I
10	*Accipiter nisus*	Eurasian Sparrowhawk	WV	C	1			1	*	Sch-I
2	**Aegithalidae**									
11	*Aegithalos concinnus*	Black-throated Tit	R	I	6	4		10	*	
12	*Aegithalos iouschistos*	Black-browed Tit	SV	I		1		1	*	
3	**Alcedinidae**									
13	*Megaceryle lugubris*	Crested Kingfisher	R	P		1		1	*	
14	*Halcyon smyrnensis*	White-throated Kingfisher	SV	P		2		2	*	
15	*Halcyon pileata*	Black-capped Kingfisher	SV	P		3		3	*	
4	**Apodidae**									
16	*Hirundapus caudacutus*	White-throated Needletail	SV	I	1	2		3	*	
17	*Aerodramus brevirostris*	Himalayan Swiftlet	WV	I	3	3		6	***	
18	*Apus pacificus*	Pacific Swift	SV	I		2		2	*	
19	*Apus affinis nipalensis*	Indian House Swift	SV	I		1		1	*	
5	**Ardeidae**									
20	*Ardeola bacchus*	Chinese Pond Heron	SV	P		3		3	*	
21	*Bubulcus ibis*	Cattle Egret	SV	I		2		2	*	
6	**Bucerotidae**									
22	*Buceros bicornis*	Great Hornbill							**	Sch-I
7	**Campephagidae**									
23	*Pericrocotus solaris*	Grey-chinned Minivet	R	I	6	11	2	19	*	
24	*Pericrocotus ethologus*	Long-tailed Minivet	R	I		4		4	***	
25	*Pericrocotus flammeus*	Scarlet Minivet	R	I		1		1	*	
8	**Cinclidae**									
26	*Cinclus pallasii*	Brown Dipper	R	I	1	4	3	8	***	
9	**Cisticolidae**									
27	*Prinia crinigera*	Striated Prinia	SV	I	2			2	*	
28	*Prinia atrogularis*	Hill Prinia	SV	I	1			1	*	
29	*Prinia flaviventris*	Yellow-bellied Prinia	SV	I				0	*	
40	*Orthotomus sutorius*	Common Tailorbird		I				0	**	
10	**Columbidae**									
41	*Streptopelia orientalis*	Oriental Turtle Dove	SV	G		2		2	*	
42	*Streptopelia tranquebarica*	Red Collared Dove	SV	G		3		3	*	
43	*Chalcophaps indica*	Emerald Dove	SV	G	1			1	*	
44	*Treron sphenurus*	Wedge-tailed Green Pigeon	SV	F		3		3	*	
11	**Corvidae**									
45	*Dendrocitta formosae*	Grey Treepie	R	O	9	16	3	28	***	
46	*Dendrocitta frontalis*	Collared Treepie	SV	O		1		1	*	
47	*Cissa chinensis*	Common Green Magpie	R	O	1	5		6	*	
48	*Corvus macrorhynchos*	Large-billed Crow	WV	O		1		1	*	
12	**Cuculidae**									
49	*Centropus sinensis*	Greater coucal		I					**	
50	*Chrysococcyx maculatus*	Asian Emerald Cuckoo	SV	I		2		2	*	
51	*Chrysococcyx xanthorhynchus*	Violet Cuckoo	SV	I		1		1	*	
52	*Cacomantis merulinus*	Plaintive Cuckoo	SV	I		1		1	*	
53	*Surniculus dicruroides*	Drongo Cuckoo	SV	I		1		1	*	

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54	*Hierococcyx sparverioides*	Large Hawk Cuckoo	SV	I	1			1	*	
55	*Hierococcyx nisicolor*	Whistling Hawk Cuckoo	SV	I		1		1	*	
56	*Cuculus micropterus*	Indian Cuckoo	SV	I	1	1		2	*	
57	*Cuculus saturatus*	Himalayan Cuckoo	SV	I	1	1		2	*	
58	*Cuculus poliocephalus*	Lesser Cuckoo	SV	I		1		1	*	
13	**Dicaeidae**									
59	*Dicaeum minullum*	Plain Flowerpecker	WV	N	1	4		5	*	
60	*Dicaeum ignipectus*	Fire-breasted Flowerpecker	R	N	1	4	1	6	*	
14	**Dicruridae**									
61	*Dicrurus macrocercus*	Black Drongo	SV	I		1		1	***	
62	*Dicrurus leucophaeus*	Ashy Drongo	R	I	8	16	2	26	*	
63	*Dicrurus annectens*	Crow-billed Drongo	SV	I		1		1	*	
64	*Dicrurus aeneus*	Bronzed Drongo	R	I	2	6		8	***	
65	*Dicrurus hottentottus*	Hair-crested Drongo	SV	I	3	9	1	13	*	
15	**Emberizidae**									
66	*Emberzia lathami*	Crested Bunting	SV	G	1			1	*	
67	*Emberzia pusilla*	Little Bunting	SV	G		1		1	*	
16	**Estrildidae**									
68	*Lonchura punctulata*	Scaly-breasted Munia	WV	G		4		4	***	
17	**Falconidae**									
69	*Falco tinnunculus*	Common Kestrel	WV	C		1		1	*	
70	*Falco severus*	Oriental Hobby	WV	C		1		1	*	
18	**Fringillidae**									
71	*Carpodacus erythrinus*	Common Rosefinch	WV	G		2		2	*	
72	*Haematospiza sipahi*	Scarlet Finch	WV	G		1		1	*	
73	*Pyrrhoplectes epauletta*	Gold-naped Finch	WV	G	2			2	*	
19	**Hirundinidae**									
74	*Delichon nipalense*	Nepal House Martin	R	I		4		4	*	
75	*Riparia chinensis*	Grey throated sand Martin	R	I				0	*	
76	*Cecropis daurica*	Red-rumped Swallow	WV	I		4		4	*	
20	**Indicatoridae**									
77	*Indicator xanthonotus*	Yellow-rumped Honeyguide	SV	I					*	
21	**Irenidae**									
78	*Irena puella*	Asian Fairy-bluebird	SV	I		1		1	*	
79	*Chloropsis hardwickii*	Orange-bellied Leafbird	R	O	20	38	4	62	***	
22	**Laniidae**									
80	*Lanius cristatus*	Brown Shrike	SV	I		2		2	*	
81	*Lanius tephronotus*	Grey-backed Shrike	SV	I		3		3	*	
23	**Leiothrichidae**									
82	*Cutia nipalensis*	Cutia	WV	I	1			1	*	
83	*Garrulax striata*	Striated Laughingthrush	R	I		2		2	*	
84	*Garrulax leucolophus*	White-crested Laughingthrush	R	I	4	16	1	21	***	
85	*Garrulax caerulatus*	Grey-sided Laughingthrush	WV	I		2		2	*	
86	*Garrulax ruficollis*	Rufous-necked Laughingthrush	WV	I		1		1	*	
87	*Garrulax variegatum*	Variegated Laughingthrush	WV	I					*	
88	*Garrulax affine*	Black-faced Laughingthrush	WV	I					*	
89	*Garrulax rufogularis*	Rufous-chinned Laughingthrush	WV	I		2		2	*	

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90	*Trochalopteron erythrocephalum*	Chestnut-crowned Laughingthrush	R	I		2		2	*	
91	*Leiothrix argentauris*	Silver-eared Mesia	R	I	2	5		7	*	
92	*Leiothrix lutea*	Red-billed Leiothrix	WV	I					*	
93	*Minla ignotincta*	Red-tailed Minla	R	I	1	3		4	*	
94	*Liocichla phoenicea*	Red-faced Liocichla	SV	I					*	
95	*Actinodura nipalensis*	Hoary-throated Barwing	R	I	3	1		4	*	
96	*Chrysominla strigula*	Chestnut-tailed Minla	SV	I		2		2	*	
97	*Actinodura egertoni*	Rusty-fronted Barwing	SV	I		2		2	*	
24	**Locustellidae**									
98	*Locustella luteoventris*	Brown Bush Warbler	SV	I					*	
99	*Locustella thoracica*	Spotted Bush Warbler	SV	I					*	
100	*Megalurus palustris*	Striated Grassbird	SV	I	2	6		8	*	
25	**Motacillidae**									
101	*Anthus hodgsoni*	Olive-backed Pipit	WV	I	1	3		4	***	
102	*Motacilla flava*	Western Yellow Wagtail	SV	I			1	1	*	
103	*Motacilla cinerea*	Grey Wagtail	SV	I	1	2		3	***	
104	*Motacilla citreola*	Citrine Wagtail	WV	I		2		2	*	
105	*Motacilla alba*	White Wagtail	WV	I		8		8	***	
26	**Muscicapidae**									
106	*Copsychus saularis*	Oriental Magpie Robin	SV	I		2		2	*	
107	*Muscicapa sibirica*	Dark-sided Flycatcher	SV	I	1	1		2	*	
108	*Muscicapa ferruginea*	Ferruginous Flycatcher	SV	I	1	2		3	*	
109	*Cyornis rubeculoides*	Blue-throated Flycatcher	SV	I					*	
110	*Anthipes monileger*	White-gorgeted Flycatcher	SV	I		1		1	*	
111	*Eumyias thalassinus*	Verditer Flycatcher	R	I	1	4		5	*	
112	*Ficedula westermanni*	Little pied Flycatcher		I					**	
113	*Ficedula albicilla*	Taiga Flycatcher	SV	I		1		1	*	
114	*Ficedula tricolor*	Slaty-blue Flycatcher	SV	I		2		2	*	
115	*Niltava sundara*	Rufous-bellied Niltava	R	I		1		1	*	
116	*Niltava grandis*	Large Niltava	R	I		2		2	*	
117	*Niltava macgrigoriae*	Small Niltava	SV	I		1		1	*	
118	*Brachypteryx hyperythra*	Rusty-bellied Shortwing	SV	I					*	
119	*Larvivora brunnea*	Indian Blue Robin	SV	I					*	
120	*Myiomela leucura*	White-tailed Robin	SV	I		1		1	*	
121	*Tarsiger indicus*	White-browed Bush Robin	SV	I		1		1	*	
122	*Tarsiger chrysaeus*	Golden Bush Robin	W	I		1		1	*	
123	*Tarsiger rufilatus*	Himalayan Bush Robin	WV	I		2		2	*	
124	*Tarsiger hyperythrus*	Rufous-breasted Bush Robin	WV	I		17	3	20	*	
125	*Saxicola ferreus*	Grey Bushchat	SV	I		2		2	*	
126	*Enicurus scouleri*	Little Forktail	WV	I		1		1	***	
127	*Enicurus immaculatus*	Black-backed Forktail	WV	I		2		2	*	
128	*Enicurus schistaceus*	Slaty-backed Forktail	R	I		9	2	11	*	
129	*Enicurus maculatus*	Spotted Forktail	WV	I		3		3	***	
130	*Adelura frontalis*	Blue-fronted Redstart	WV	I		3		3	*	
131	*Rhyacornis fuliginosa*	Plumbeous Water Redstart	R	I	4	8	3	15	***	
132	*Chaimarrornis leucocephalus*	White-capped Water Redstart	R	I		1	1	2	***	
133	*Phoenicurus hodgsoni*	Hodgson's Redstart	WV	I		4	1	5	***	
134	*Phoenicurus ochruros*	Black Redstart	WV	I		1		1	*	
135	*Phoenicurus auroreus*	Daurian Redstart	WV	I		3	1	4	*	

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136	*Phoenicurus erythrogastrus*	~~Güldenstädt~~ White-winged Redstart	WV	I			1	1	*	
137	*Myophonus caeruleus*	Blue Whistling Thrush	R	O	18	32	9	59	***	
138	*Monticola rufiventris*	Chestnut-bellied Rock Thrush	R	O		2		2	*	
139	*Monticola solitarius*	Blue rockthrush		O					**	
27	**Nectariniidae**									
140	*Arachnothera magna*	Streaked Spiderhunter	R	N	17	28		45	*	
141	*Aethopyga saturata*	Black-throated Sunbird	R	N	16	7		23	*	
142	*Aethopyga nipalensis*	Green-tailed Sunbird	R	N	3	5	1	9	*	
143	*Aethopyga gouldiae*	Mrs Gould's Sunbird	WV	N			1	1	*	
28	**Oriolidae**									
144	*Oriolus traillii*	Maroon Oriole	SV	O	1	4		5	*	
29	**Paridae**									
145	*Melanochlora sultanea*	Sultan Tit	WV	I		1		1	*	
146	*Parus monticolus*	Green-backed Tit	WV	I	2	1		3	***	
147	*Parus spilonotus*	Yellow-cheeked Tit	WV	I		4		4	*	
30	**Passeridae**									
148	*Passer montanus*	Eurasian Tree Sparrow	R	G	2	5		7	***	
31	**Pellorneidae**									
149	*Malacocincla abbotti*	Abbott's Babbler	SV	I					*	
150	*Trichastoma tickelli*	Buff-breasted Babbler	SV	I		1		1	*	
151	*Schoeniparus rufogularis*	Rufous-throated Fulvetta	R	I		2		2	*	
152	*Schoeniparus cinereus*	Yellow-throated Fulvetta	R	I	1			1	*	
153	*Schoeniparus castaneceps*	Rufous-winged Fulvetta	WV	I		2		2	*	
154	*Alcippe nipalensis*	Nepal Tit Babbler	R	I					*	
32	**Phalacrocoracidae**									
156	*Microcarbo niger*	Little Cormorant	WV	P	1	4	2	7	*	
157	*Phalacrocorax fuscicollis*	Indian Cormorant	WV	P		2		2	*	
158	*Phalacrocorax carbo*	Great Cormorant	WV	P	2		2	4	*	
33	**Phasianidae**									
159	*Arborophila torqueola*	Common Hill Partridge	R	G	3			3	*	
160	*Arborophila rufogularis*	Rufous-throated Hill Partridge	SV	G	2			2	*	
161	*Polyplectron bicalcaratum*	Grey Peacock Pheasant	WV	O		2		2	*	Sch-I
162	*Lophura leucomelanos*	Kalij Pheasant	R	O	10	11		21	*	
34	**Phylloscopidae**									
163	*Phyloscopus chloronotus*	Lemon-rumped Warbler	WV	I	2	5		7	*	
164	*Phyloscopus maculipennis*	Ashy-throated Warbler	WV	I		2		2	*	
165	*Phylloscopus fuscatus*	Dusky Warbler	SV	I					*	
166	*Phylloscopus affinis*	Tickell's Leaf Warbler	WV	I	4	1		5	*	
167	*Phylloscopus Intermedius*	White-spectacled Warbler	WV	I	1	3		4	*	
168	*Phylloscopus poliogenys*	Grey-cheeked Warbler	R	I	2	2		4	*	
169	*Phylloscopus tephrocephalus*	Grey-crowned Warbler	R	I		1		1	*	
170	*Phylloscopus whistleri*	Whistler's Warbler	WV	I					*	
171	*Phylloscopus castaniceps*	Chestnut-crowned Warbler	SV	I	2			2	*	

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172	*Phylloscopus trochiloides*	Greenish Leaf Warbler	SV	I		1		1	*	
173	*Phylloscopus magnirostris*	Large-billed Leaf Warbler	SV	I					*	
174	*Phylloscopus cantator*	Yellow-vented Leaf Warbler	SV	I	4	7		11	*	
175	*Phylloscopus reguloides*	Blyth's Leaf Warbler	WV	I		1		1	*	
176	*Phylloscopus xanthoschistos*	Grey-hooded Leaf Warbler	R	I	2	8		10	*	
35	**Picidae**									
177	*Picumnus innominatus*	Speckled Piculet	WV	I					*	
178	*Dendrocopos canicapillus*	Grey-capped Pygmy Woodpecker	WV	I		1		1	*	
179	*Gecinulus grantia*	Pale-headed Woodpecker	WV	I		2		2	*	
180	*Micropternus brachyurus*	Rufous Woodpecker	SV	I	2			2	*	
181	*Blythipicus pyrrhotis*	Bay Woodpecker	SV	I		1		1	*	
182	*Dendrocopos darjellensis*	Darjeeling Pied Woodpecker	SV	I					*	
183	*Picus canus*	Grey-headed Woodpecker	WV	I	2	3		5	*	
184	*Chrysophlegma flavinucha*	Greater Yellow-naped Woodpecker	R	I		1		1	*	
185	*Picus chlorolophus*	Lesser Yellow-naped Woodpecker	R	I	1	3		4	*	
36	**Pnoepygidae**									
186	*Pnoepyga pusilla*	Pygmy Wren Babbler	SV	I	1			1	*	
37	**Prunellidae**									
187	*Prunella strophiata*	Rufous-breasted Accentor	WV	I		2		2	*	
38	**Pycnonotidae**									
188	*Alophoixus flaveolus*	White-throated Bulbul	SV	O	1	2		3	*	
189	*Ixos mcclellandii*	Mountain Bulbul	R	O	1			1	*	
190	*Hypsipetes leucocephalus*	Black Bulbul	R	F	8	18		26	***	
191	*Pycnonotus jocosus*	Red-whiskered Bulbul	WV	O	14	3		17	***	
192	*Pycnonotus leucogenys*	Himalayan Bulbul	SV	O		2		2	*	
193	*Pycnonotus cafer*	Red-vented Bulbul	SV	O		2		2	***	
39	**Rallidae**									
194	*Amaurornis phoenicurus*	White-breasted Waterhen	WV	O		1		1	*	
40	**Ramphastidae**									
195	*Psilopogon virens*	Great Barbet	R	F	20	14		34	*	
196	*Psilopogon asiaticus*	Blue throated barbet		F					**	
197	*Psilopogon lineatus*	Lineated Barbet	SV	F	2	3	1	6	*	
198	*Psilopogon franklinii*	Golden-throated Barbet	SV	F	3			3	*	
41	**Rhipiduridae**									
199	*Rhipidura albicollis*	White-throated Fantail	WV	I		2		2	*	
42	**1**									
200	*Numenius arquata*	Eurasian Curlew	WV	I			1	1	*	
43	**Scotocercidae**									
201	*Tesia olivea*	Slaty-bellied Tesia	SV	I		5		5	*	
202	*Tesia cyaniventer*	Grey-bellied Tesia	SV	I					*	
203	*Cettia castaneocoronata*	Chestnut-headed Tesia	SV	I					*	
204	*Cettia major*	Chestnut-crowned Bush Warbler	SV	I		1		1	*	
205	*Cettia brunnifrons*	Grey-sided Bush Warbler	SV	I					*	

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206	*Hemitesia pallidipes*	Pale-footed Bush Warbler	R	I					*	
207	*Cettia fortipes*	Brownish-flanked Bush Warbler	R	I					*	
208	*Abroscopus albogularis*	Rufous-faced Warbler	R	I		1		1	*	
209	*Abroscopus schisticeps*	Black-faced Warbler	WV	I		1		1	*	
44	**Sittidae**									
210	*Sitta himalayensis*	White-tailed Nuthatch	WV	I					*	
211	*Sitta frontalis*	Velvet-fronted Nuthatch	WV	I					*	
212	*Tichodroma muraria*	Wallcreeper	WV	I					*	
45	**Stenostiridae**									
213	*Chelidorhynx hypoxanthus*	Yellow-bellied Fairy-fantail	WV	I	16	38	7	61	***	
214	*Culicicapa ceylonensis*	Grey-headed Canary-flycatcher	SV	I	2			2	*	
46	**Strigidae**									
215	*Glaucidium brodiei*	Collared Owlet	WV	C		1		1	*	
216	*Glaucidium cuculoides*	Asian Barred Owlet	WV	C		4		4	*	
217	*Otus spilocephalus*	Mountain Scops Owl	R	C		2		2	*	
218	*Otus bakkamoena*	Collared Scops Owl	WV	C		1		1	*	
47	**Sturnidae**									
219	*Acridotheres tristis*	Common Myna		O					**	
220	*Sturnia malabarica*	Chestnut-tailed Starling	SV	O		1		1	*	
48	**Sylviidae**									
221	*Myzornis pyrrhoura*	Fire-tailed Myzornis	R	I	5	8		13	*	
222	*Paradoxornis guttaticollis*	Spot-breasted Parrotbill	SV	O					*	
223	*Psittiparus ruficeps*	Greater Rufous-headed Parrotbill	WV	O	3	5		8	*	
224	*Suthora fulvifrons*	Fulvous Parrotbill	SV	O					*	
225	*Suthora nipalensis*	Black-throated Parrotbill	R	O	2			2	*	
226	*Chleuasicus atrosuperciliaris*	Lesser Rufous-headed Parrotbill	SV	O	3			3	*	
49	**Timaliidae**									
227	*Pomatorhinus ruficollis*	Streak-breasted Scimitar Babbler	SV	O					*	
228	*Stachyris nigriceps*	Grey-throated Babbler	SV	O					*	
229	*Sphenocichla humei*	Wedge-billed Babbler	SV	I		2		2	*	
230	*Cyanoderma chrysaeum*	Golden Babbler	R	I	2	5		7	*	
231	*Cyanoderma ruficeps*	Rufous-capped Babbler	R	I	3	8		11	*	
232	*Mixornis gularis*	Striped Tit Babbler	SV	I					*	
50	**Troglodytidae**									
233	*Troglodytes*	Eurasian Wren	SV	I					*	
51	**Trogonidae**									
234	*Harpactes erythrocephalus*	Red-headed Trogon	WV	I		2		2	***	
235	*Harpactes wardi*	Ward's Trogon	WV	I		1		1	*	
52	**Turdidae**									
236	*Turdus eunomus*	Dusky Thrush	SV	O					*	
53	**Upupidae**									
237	*Upupa epops*	Common Hoopoe	SV	I		4		4	*	
54	**Vangidae**									
238	*Hemipus picatus*	Bar-winged Flycatcher-shrike	WV	I	3			3	*	

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55	**Vireonidae**									
239	*Pteruthius aeralatus*	Blyth's Shrike-babbler	SV	I					*	
240	*Pteruthius melanotis*	Black-eared Shrike-babbler	WV	I		1	2	3	*	
241	*Erpornis zantholeuca*	White-bellied Erpornis	R	I					*	
56	**Zosteropidae**									
242	*Yuhina castaniceps*	Striated Yuhina	WV	I	5	1		6	*	
243	*Yuhina nigrimenta*	Black-chinned Yuhina	R	I		1		1	*	
244	*Yuhina gularis*	Stripe-throated Yuhina	WV	I		2		2	*	
245	*Yuhina flavicollis*	Whiskered Yuhina	WV	I	3	2		5	*	
246	*Yuhina occipitalis*	Rufous-vented Yuhina	SV	I			2	2	*	
247	*Yuhina bakeri*	White-naped Yuhina	R	I	6	15	3	24	*	
248	*Zosterops palpebrosus*	Oriental White-eye	SV	I	3	8		11	*	

MS – Migratory Status: R – Resident, SV – Summer Visitor, WV – Winter Visitor; FG – Foraging Guild : C – Carnivore, F – Frugivore, G -Granivore, I – Insectivore, N – Nectarivore, O- Omnivore, P – Piscivore; DR – Dri River Limb, TR – Tangon River Limb, C – Confluence Area, SA- Study Area Total, CL – Cumulative list : * recorded only in this study, ** - reported from existing information / Secondary Source, *** reported from both (present study & Secondary Source; CS – Conservation Status : Indian Wildlife Protection Act 1972 – Sch- I – Schedule I

Annexure 5.10: Overall possible Cumulative List and Conservstion Status of Mammal Species in Etalin HEP Study Area

S.No	Family Scientific Name	Common Name	Present Study – WII 2018				SS	CL	Conservation Status	
			MSCT	Social Survey		Overall Study List				
				PJA	OPJA				IUCN	WPA
1	**Ailuridae**									
1	*Ailurus fulgens*	Red Panda			✓				En	I
2	**Bovidae**									
2	*Capricornis thar*	Himalayan Serow	✓	✓		✓		*	NT	I
3	*Naemorhedus baileyi*	Red Goral			✓				Vu	III
4	*Budorcas taxicolor*	Mishmi Takin			✓				Vu	I
5	*Bos frontalis*	Mithun	✓	✓		✓	✓	***		
3	**Canidae**									
6	*Cuon alpinus*	Indian Wild Dog	✓	✓		✓	✓	***	En	II
4	**Cercopithecidae**									
7	*Macaca assamensis*	Assam Macaque	✓	✓		✓		*	NT	Sch II
5	**Cervidae**									

S.No	Family Scientific Name	Common Name	Present Study – WII 2018				SS	CL	Conservation Status	
			MSCT	Social Survey		Overall Study List				
				PJA	OPJA				IUCN	WPA
8	*Muntiacus gongshanensis*	Gongshan Muntjac	✓	✓		✓		*	DD	
9	*Muntiacus muntjac*	Indian Muntjac	✓	✓		✓	✓	***	LC	III
6	**Falidae**									
10	*Panthera tigris*	Bengal Tiger			✓				En	I
11	*Panthera pardus*	Common Leopard			✓				Vu	I
12	*Panthera uncia*	Snow Leopard			✓				Vu	I
13	*Neofelis nebulosa*	Clouded Leopard			✓				Vu	I
14	*Pardofelis marmorata*	Marbled Cat		✓		✓		*	NT	I
15	*Catopuma temmincki*	Asiatic Golden Cat	✓	✓		✓		*	NT	I
16	*Prionailurus bengalensis*	Leopard Cat	✓	✓		✓		*	LC	I
7	**Herpestidae**									
17	*Herpestes auropunctatus*	Small Indian Mongoose	✓			✓	✓	***	LC	II
8	**Hystricidae**									
18	*Aherurus marcourus*	Brush-tailed Porcupine	✓	✓		✓		*	LC	II
9	**Manidae**									
19	*Manis pentadactyla*	Chinese Pangolin	✓			✓		*	Cr	I
10	**Moschidae**									
20	*Moschus chrysogaster*	Alpine Musk Deer			✓				En	I
11	**Muridae**									
21	*Rattus nitidus*	Himalayan Field Rat	✓			✓	✓	***	LC	IV
12	**Mustelidae**									

S.No	Family Scientific Name	Common Name	Present Study – WII 2018				SS	CL	Conservation Status	
			MSCT	Social Survey		Overall Study List				
				PJA	OPJA				IUCN	WPA
22	*Martes flavigula*	Yellow - throated Marten	✓	✓		✓		*	LC	II
23	*Lutrogale perspicillata*	Smooth-coated Otter	✓	✓		✓		*	Vu	II
24	*Lutra*	Eurasian Otter		✓		✓		*	NT	II
25	*Mustela strigidorsa*	Black-striped Weasel			✓				LC	
13	**Ochotonidae**									
26	*Ochotona macrotis*	Large-eared Pika			✓				LC	
14	**Prionodontidae**									
27	*Prionodon pardicolor*	Spotted Linsang		✓		✓		*	LC	I
15	**Sciuridae**									
28	*Ratufa bicolor*	Black Giant Squirrel	✓	✓		✓		*	NT	II
29	*Callosciurus pygerythrus*	Hoary-bellied Squirrel	✓			✓	✓	***	LC	
30	*Dremomys lokriah*	Orange-bellied Squirrel		✓		✓		*	LC	
31	Callosciurus erythraeus	Pallas's Squirrel	✓	✓		✓		*	LC	
32	*Tamiops macclellandi*	Himalayan Striped Squirrel	✓	✓		✓	✓	***	LC	
33	Petaurista philippensis	Indian Giant Flying Squirrel		✓		✓		*	LC	II
16	**Soricidae**									
34	*Crocidura attenuate*	Asian Grey Shrew	✓			✓		*	LC	
35	*Soriculus nigrescens*	Himalayan Large-clawed Shrew			✓				LC	
17	**Suidae**									

S.No	Family Scientific Name	Common Name	Present Study – WII 2018				SS	CL	Conservation Status	
			MSCT	Social Survey		Overall Study List				
				PJA	OPJA				IUCN	WPA
36	*Sus scrofa*	Indian Wild Pig	✓	✓		✓	✓	***	LC	III
18	**Talpidae**									
37	*Parascaptor leucura*	White-tailed Mole			✓				LC	IV
18	**Ursidae**									
38	*Ursus thibetanus*	Himalayan Black Bear	✓	✓		✓	✓	***	Vu	II
19	**Vespertilionidae**									
39	*Eptesicus hottentotus*	Long-tailed House Bat					✓	**	LC	
40	*Eptesicus spp.*	Bat (un id)	✓						?	
20	**Viverridae**									
41	*Paguma larvata*	Himalayan Palm Civet	✓	✓		✓		*	LC	II
42	*Viverra zibetha*	Large Indian Civet					✓	**	LC	II
	Total Species		**22**	**22**	**12**		**11**			
				34		**27**		**29**		

MSCT - Species reported present mammal survey, PJA – Project Area : species reported present social Survey, OPJA – Outside Project Area : species reported from upper reaches – social survey, SS – Species listed from Secondary Source : listed & sighted in EIA 2015; IUCN Red List - EN –Endangered, VU- Vulnerable, LC-Least Concerned, NT- Near Threatened, WPA – Wildlife Protection Act 1972 : Schedule I & II

Annexure 5.11: Fish Species found in the Etalin HEP Study Area with their Migration Pattern

Fish Name	Mishmi Name	English Name	Common Habitat	Sensitive to Habitat Change	Feeding Habit	Potential Breeding Time	Flow Tolerance (m^3/s)	Position in Water Column	Migratory Habit
Aborichthys sp	Aekabru	Loach	Riffle-Pool	Highly sensitive	Insectivore	May-June	1 to 3	Bottom	Short distance
Creteuchiloglanis arunachalensis	Ayupipa	Catfish	Riffle-Pool	Highly sensitive	Insectivore	May-June	1 to 2	Bottom	Short distance
Exostoma labiatum	Ayu	Burmese catfish	Riffle-Pool	Highly sensitive	Insectivore	May-June	1 to 2	Bottom	Short distance
Garra kempi	Apaapa	Kempi garra	Run- Pool	Low	Algivore	April-May	1 to 2	Bottom	Short distance
Garra magnidiscus	Apappa	Garra	Run- Pool	Low	Algivore	April-May	0 to 1	Bottom	Short distance
Parachiloglanis bhutanensis	Ayu	Bhutan catfish	Cascade-riffle	Highly sensitive	Insectivore	June	0 to 1	Bottom	Short distance
Pseudecheneis sulcate	Awopa	Sucker throat catfish	Cascade-riffle	Moderate	Insectivore	June	0 to 1	Bottom	Short distance
Psilorhychus arunachalensis	Ayumbo	Mountain carp	Cascade-riffle	Highly sensitive	Insectivore	May-June	0 to 1	Bottom	Short distance
Schizothorax progastus	Anga	Dinnawah snow trout	Run-pool	Moderate	Omnivore	September-October	0 to 3	Mid	Long stance
Schizothorax richardsonii	Anga	Common snow trout	Run-pool	Highly sensitive	Herbivore	March-May & Sept-Oct	0 to 3	Mid	Long stance
Schistura sp	Aekabru	Loach	Riffle-pool	Moderate	Insectivore	May-June	0 to 1	Bottom	Short distance
Tor sp	Abro	Mahseer	Run-pool	Highly sensitive	Omnivore	May-June	0 to 1	Mid	Long stance

Sensitivity* - Based on field knowledge and consulting with fish biologist; Feeding habit and breeding time is based on field observation and Fishbase; Migration pattern is based on species; Flow tolerance values are based on primary data i.e. flow values ranged from 0 to 3 m^3/s in each segment during the study period.

Annexure 5.12 a: Household details of Anini Circle / Dri Limb

		Anini Circle / Dri limb		
S.No.	**PAVs**	**No of Household Census- 2011**	**PAF**	**PAFs Surveyed**
1.	Punli	19	31	17
2.	Ayeso	1	6	1
3.	Akobe	11	23	8
4.	Yuron	23	10	3
5.	Apayee	-	11	0
6.	Aguli	8	10	5
7.	Matuli	4	0	8
8.	Kaduli	12	0	8
9.	Imuli	3	0	2
	Total	**81**	**91**	**52**

PAVs: Project Affected Villages, PAFs: project Affected Families.

Annexure 5.12 b: Household Details of Etalin Circle/ Tangon Limb

Etalin Circle / Tangon limb				
S.No.	**PAVs**	**No of Household Census-2011**	**PAF**	**PAFs Surveyed**
1.	Etalin HQ	64	42	34
2.	Etalin Bridge Point	41	62	34
3.	New Aropo	16	16	12
4.	Emuli	13	7	0
5.	Punli	4	5	3
6.	Aruli	11	19	12
7.	Athunli	11	25	11
8.	Edili*	1	1	1
9.	Aunli	5	10	6
10.	Apunli	6	4	0
11.	Aliwu	-	3	1
12	Atyi	3	8	4
13	Azuli	-	2	2
14	Amuchi**	3	0	4
15	Maayi ***	-	0	3
	Total	179	203	127

* In list of PAFs (Social Impact Assessment and Resettlement & Rehabilitation (R & R) Plan of EHEP Project, January 2015) combined list of PAFs of Athunli & Edili is prepared. ** In list of PAFs (Social Impact Assessment and Resettlement & Rehabilitation (R & R) Plan of EHEP Project, January 2015) combined list of PAFs of Aruli & Amuchi is prepared. *** In list of PAFs (Social Impact Assessment and Resettlement & Rehabilitation (R & R) Plan of EHEP Project, January 2015) combined list of PAFs of Etalin HQ & Maayi is prepared

Annexure 5.13: List of Mammals Hunted, their purpose and Distribution

S.No.	Idu (local) Name	Common Name	Found at	Purpose of Hunting	Conservation Status	
					IUCN	WPA
1	Manjo	Barking Deer	PA	Consumption of Meat; hide used as carpet	LC	
2	Manjoimbo	Gongshan Munjtac	PA & H-al	Consumption of Meat, hide used as carpet	DD	
3	Ahu	Asiatic Himalayan Black Bear	PA	Consumption of Meat, Commercial (Selling of Gall Bladder), Raiding of Crops	Vu	Sch – II
4	Ma(r)ye	Himalayan Serow	PA	Consumption of Meat	NT	Sch – I
5	Aprupu	Wild Dog	PA	Cattle Lifting	En	Sch – II
6	Akoko	Yellow throated Marten	PA	Poultry Lifting	LC	
7	Achango	Leopard Cat	PA	Poultry Lifting	LC	
8	Ami	Red Goral	H-al	Consumption of meat, hide used as carpet	Vu	
9	Ala	Alpine Musk Deer	H-al	Consumption of meat, Commercial (Sell of Musk Pod)	En	Sch – I
10	Amme	Wild Pig	PA	Consumption of Meat, Raiding of Crops	LC	Sch – III
11	Ameh	Macaque	PA	Consumption of Meat, Raiding of Crops	En	Sch – II
12	Awkru	Mishmi Takin	WM – L -al	Consumption of Meat	Vu	Sch – I
13	Katoh	Spotted Linsang	PA	Consumption of Meat	LC	Sch – I
14	Amra	Tiger	H-al	Taboo; Tiger is not hunted as it is considered as next to human kin	En	Sch – I
15	Kichi duru	Common Leopard	H-al	Taboo	Vu	Sch – I
16	Kichi mano	Snow Leopard	H-al	Taboo	Vu	Sch – I
17	Kichi aruyi	Clouded Leopard	H-al	Taboo	Vu	Sch – I
18	Agri	Red Giant Flying Squirrel	PA	Consumption of Meat	LC	

S.No.	Idu (local) Name	Common Name	Found at	Purpose of Hunting	Conservation Status	
					IUCN	WPA
19	Api	Himalayan Palm Civet	PA	Consumption of Meat	LC	Sch – II
20	Aiminjini	Red Panda	H-al	Consumption of Meat	En	Sch – I
21	Awroga	Smooth Coated Otter	PA	Consumption of Meat, skin	Vu	Sch – II
22	Awro	Eurasian Otter	PA	Consumption of Meat, skin	NT	
23	Ali	Brush Tailed Porcupine	PA	Consumption of Meat	LC	Sch – II
24	Etophu	Black Giant Squirrel	PA	Consumption of Meat	NT	
25	Adashumbo	Palla's Squirrel	PA	Consumption of Meat	LC	
26	Adaka	Himalayan Striped Squirrel	PA	Consumption of Meat	LC	
27	Anoche	Orange Bellied Squirrel	PA	Consumption of Meat	LC	
28	Asha	Large Eared Pika	H-al	Consumption of Meat	LC	
29	Apibu	Himalayan Large Clawed Shrew	PA	Consumption of Meat	LC	
30	Kamney	Indian Giant Flying Squirrel	PA	Consumption of Meat	LC	

PA - animal found in and around the project area. H-al – animals found in High altitude forests, WM-L al – Winter migrant to Lower altitude.

Annexure 5.14. List of birds hunted by the locals and their conservation status

S.No.	Idu (local) Name	Common Name	Found at	Conservation Status	
				IUCN	WPA
1	Prabana	Banded Bay Cuckoo	PA	LC	Sch-IV
2	Praho	Lesser Racket Tailed Drongo	PA	LC	Sch-IV
3	Poko	Orange Breasted Green Pigeon	PA	LC	Sch-IV
4	Puku	white Crested Laughing Thrush	PA	LC	Sch-IV
5	Egiku	Blue Winged Laughing Thrush	PA	LC	Sch-IV
6	Pramayo	White Naped Yuhina	PA	LC	
7	Prakre	Stripe Throated Yuhina	PA	LC	
8	Paita	Blue Whistling Thrush	PA	LC	Sch-IV
9	Prowo	Rufous Breasted Bush Robin	PA	LC	
10	Paiba	Chestnut Breasted Partridge	PA	Vu	Sch-IV
11	Dikhi	Crested Serpent Eagle	PA	LC	
12	Poko	Green Imperial Pigeon	PA	LC	Sch-IV
13	Ekomi	Wedge Tailed Green Pigeon	PA	LC	Sch-IV
14	Pidi	Himalayan Monal	H-al	LC	Sch-I
15	Puthu	Rufous necked Hornbill	PA	Vu	Sch-I
16	Aro	Kalij Pheasant	PA	LC	Sch-I
17	Peba eche	Sclater's Monal	H-al	Vu	Sch-I
18	Peba ala	Temminck's Tragopan	H-al	LC	Sch-I
19	Chenda	Blood Pheasant	H-al	LC	Sch-I
21	Perah	Hill Partridge	PA	LC	Sch-IV
22	Pando meya	Common Hoopoe	PA	LC	
23	Eshwu	Fulvous Breasted Woodpecker	PA	LC	Sch-IV
24	Prakarya	Large Billed Crow	PA	LC	Sch-IV
25	Pratha	Black Bulbul	PA	LC	Sch-IV
26	Pratha	Square Tailed Bulbul	PA	LC	Sch-IV
27	Aechopo	Scaly Breasted wren-babbler	PA	LC	Sch-IV
28	Tiji	Winter Wren	PA	LC	Sch-IV
29	Pala	Plain Martin	PA	LC	
30	Prayi	Spotted forktail	PA	LC	
31	Protoh	Rufous Bellied Niltava	PA	LC	
32	Praiee	Streaked Spider Hunter	PA	LC	

S.No.	Idu (local) Name	Common Name	Found at	Conservation Status	
				IUCN	WPA
33	Pokoh	Rufous throated Partridge	PA	LC	Sch-IV
34	Dohoyo	Oriental Honey Buzzard	PA	LC	
35	Pushu	Common Iora	PA	LC	
36	Pudu	Brown Shrike	PA	LC	
37	Praho	Greater Racket Tailed Drongo	PA	LC	Sch-IV
38	Prauuh	Black Drongo	PA	LC	Sch-IV
39	Pamayo	Great Tit	PA	LC	Sch-IV
40	Arunje	Himalayan Wedge Billed Babbler	PA	LC	Sch-IV
41	Peka	Long Tailed Sibia	PA	LC	Sch-IV
42	Pudu	Spot Breasted Parrotbill	PA	LC	Sch-IV

Source: Field Survey

Annexure 7.1. Dominants Tree, Shrub and Climber species suggested for Afforestation Programme

S.No.	Top IVI Tree species	S.No	Top PVI Shrub species	S.No	Top PVI Climber Species
1	*Castonopsis indica*	1	*Psychotria monticola*	1	*Rhaphitophora decursiva*
2	*Engelhardtia spicata*	2	*Piper pedicellatum*	2	*Tetrastigma affine*
3	*Macaranga denticulata*	3	*Strobilanthes sp.*	3	*Piper clerki*
4	*Lithocarpus pachyphyllus*	4	*Rhynchotechum ellipticum*	4	*Smilax* sp.
5	*Ficus semicordata*	5	*Oreocnide sp.*	5	*Clematis acuminata*
6	*Diploknema butyraceoides*	6	*Rubus ellipticus*	6	*Stephania* sp.
7	*Ostodes paniculata*	7	*Phlocanthus curviflorus*	7	*Periploca calophylla*
8	*Lithocarpus fenestratus*	8	*Laportea sp.*	8	*Milletia pachycoyea*
9	*Castanopsis tribuloides*	9	*Boehmeria macrophylla*	9	*Piper* sp 3.
10	*Litsea cubeba*	10	*Sambucus hookeri*	10	*Piper sylvertica*
11	*Bischofia javanica*	11	*Chloranthus elatior*	11	*Rhaphidophora hookeri*
12	*Kydia calycina*	12	*Debregeasia sp.*	12	*Poilokospermum lanceolatum*
13	*Terminalia myocarpa*	13	*Boehmeria longifolia*	13	*Piper* sp 4.
14		14	*Solanum spirale*	14	*Piper* sp 1
15				15	*Piper rhytidocarpun*

S.No.	Top IVI Tree species	S.No	Top PVI Shrub species	S.No	Top PVI Climber Species
16				16	*Embilya floribunda*
17				17	*Steptoleleon volabulis*
18				18	*Acacia pennata*
Total	13 Species		14 Species		18 Species
Total no. of Plant Species Recommended 45 species					

Annexure 7.2. List of plant species suggested for Green Shelterbelt – Phyto- remediation

S. No.	Name of the Species	Habit	S Sp	Ad Sp	S. No.	Name of the Species	Habit	S Sp	Ad Sp
1	*Ailanthus excels*	**Tree**	*		25	*Ficus cuneata*	**Tree**		+
2	*Ailanthus integrifolia*	**Tree**		+	26	*Ficus cyrtophylla*	**Tree**		+
3	*Albizia chinensis*	**Tree**	*		27	*Ficus heterophylla*	**Tree**		+
4	*Albizia procera*		*		28	*Ficus hookeriana*	**Tree**		+
5	*Alnus nepalensis*	**Tree**		+	29	*Ficus lacor*	**Tree**		+
6	*Alnus nitida*	**Tree**	*		30	*Ficus semicordata*	**Tree**	*	
7	*Artocarpus chama*	**Tree**		+	31	*Garcinia cowa*	**Tree**		+
8	*Bambusa balacoa*	**Tree**		+	32	*Garcinia elliptica*	**Tree**		+
9	*Bambusa pallid*	**Tree**		+	33	*Lagerstroemia parviflora*	**Tree**	*	
10	*Bambusa tulda*	**Tree**		+	34	*Mallotus philippensis*	**Tree**	*	
11	*Bauhinia ovatifolia*	**Tree**		+	35	*Mangifera sylvatica*	**Tree**		+
12	*Bauhinia purpurea*	**Shrub**	*		36	*Murraya paniculata*	**Shrub**	*	
13	*Bischofia javanica*	**Tree**	*		37	*Pinus khosiono*	**Tree**		+
14	*Bridelia retusa*	**Tree**	*		38	*Pinus roxburghii*	**Tree**		+
15	*Caesalpinia spinosa*	**Shrub**		+	39	*Pinus wollichiono*	**Tree**		+
16	*Calotropis gigantea*	**Shrub**	*		40	*Psidium guajava*	**Tree**	*	
17	*Citrus aurantium*	**Tree**	*		41	*Quercus semiserrata*	**Tree**		+
18	*Citrus limon*	**Shrub**	*		42	*Spondias pinnata*	**Tree**	*	
19	*Commelina benghalensis*	**Tree**	*		43	*Syzygium formosum*	**Tree**		+
21	*Dendrocalamus strictus*	**Tree**	*		44	*Terminalia bellirica*	**Tree**	*	
21	*Dendrocalamus giganteus*	**Tree**		+	45	*Terminalia chebula*	**Tree**	*	
22	*Dendrocalamus hamiltonii*	**Tree**		+	46	*Terminalia myriocarpa*	**Tree**		+
23	*Erythrina variegata*	**Tree**	*		47	*Trema orientalis*	**Tree**	*	

S. No.	Name of the Species	Habit	S Sp	Ad Sp	S. No.	Name of the Species	Habit	S Sp	Ad Sp
24	*Ficus roxburghii*	**Tree**	*						
	Total Species (DSS)	**Directly Selected Species *(DSS)* = 23**							
	Total Species (GBSA)	**Genera based species added *(GBSA)* = 24**							
	Grand Total	**Overall Recommended Species = 47**							

S Sp: Slected Species from CPCB 2000; Ad SP : Genera from CPCB 2000 and species of the specific genus selected form present study list made based on the survey

Annexure 7.3: Observed feeding plants of some common butterflies of the Etalin HEP study area (Modified as per field specificity from Gay et al., 1992)

S. No.	Family / Scientific Name	Common Name	Feeding plants	Habit
	Family:			
1	*Troides Helena cerberus*	Common Birdwing	*Aristolochia indica*	Climber
2	*Graphium sp.*	Bluebottle	*Cinnamon sp* *Laurels sp*	Tree
3	*Catopsilia Pomona crocale*	Common Emigrant	*Cassia* sp	Shrub
4	*Catopsilia pyranthe pyranthe*	Mottled emigrant	*Cassia occidentalis*	Shrub
	Lycaenidae			
5	*Pseudozizeeria maha maha*	Pale Grass Blue	*Oxalis corniculate*	Herb
6	*Lampides boeticus*	Peablue	Flame of the forest Pods of cultivated peas, grams and beans	Tree Herb
7	*Jamides celeno*	Common Cerulean	Flame of the forest	Tree
8	*Loxura atymnus continentalis*	Yamfly	*Dioscorea pentaphylla* *Smilax* sp	Climber Climber
	Nymphalidae			
9	*Tirumala septentrionis septentrionis*	Blue Tiger	*Hoya* sp	Climber
10	*Lethe rohria rohria*	Common Tree Brown	Bamboo	Herb
11	*Ypthima hubneri*	Common Fourring	Grasses	Herb
12	*Ypthima sakra sakra*	Common Fivering	Grasses	Herb
13	*Argynnis hyperbius hyperbius*	Indian Fritillary	*Viola sp*	Herb

S. No.	Family / Scientific Name	Common Name	Feeding plants	Habit
14	*Junonia oithya*	Blue Pansy	*Justicia sp*	Shrub
15	*Junonia iphita iphita*	Chocolate Pansy	*Justicia sp*	Shrub
16	*Vanessa cardui*	Painted Lady	*Artemisia sp* *Blumea* sp *Urtica* sp	Herb Herb Shrub
17	*Cyretis thyodamas thyodamas*	Common Map	*Ficus sp*	Tree
18	*Neptis hylas varmona*	Common Sailer	*Grewia* sp *Mucuna sp*	Tree Climber
19	Athyma perius *perius*	Common Sergeant	*Glochidion sp.*	Tree
20	*Rohana parisatis parisatis*	Black Prince	*Celtis tetrandra*	Tree
21	*Libythea lepitalepita*	Common Beak	*Boehmeria* sp *Debregasia sp* *Buddleja sP* *Celtis sp*	Shrub Shrub Tree
	Hesperiidae			
22	*Hasora chromus chromus*	Common Banded Awl	*Ricinus communis*	Shrub
23	*Notocrypta sp.*	Grass Demon	*Curcuma* sp *Hedychium sp*	Herb Herb

Annexure 7.4: Larval host plants of some common butterflies of the Etalin HEP Study Area (Modified as per field specificity from Kunte, 2008)

S. No.	Family / Scientific Name	Common Name	Larval Host Plant	Habit
	Papilionidae			
1	*Graphium sarpedon sarpedon*	Common Bluebottle	*Alseodaphne* sp *Cinnamomum sp* *Litsea sp*	Tree Tree Tree
2	*Graphium doson axion*	Common Jay	*Cinnamomum sp* *Magnolia sp* *Michelia champaca*	Tree Tree Tree
3	*Papilio polytes Romulus*	Common Mormon	*Citrus aurantifolia* *C. limon* *Murraya paniculata*	Tree Shrub/Tree Shrub/Tree
4	*Catopsilia pomona crocale*	Common Emigrant	*Cassia sp* *Bauhinia sp*	Shrub Tree
5	*Catopsilia pyranthe pyranthe*	Mottled Emigrant	*C. occidentalis*	Shrub
	Lycaenidae			
6	*Neptis hylas varmona*	Common Sailer	*Bombyx ceiba* *Grewia sp* *Mucuna purpurea*	Tree Tree Climber
7	*Lampides boeticus*	Peablue	*Pisum sativum*	Herb
	Nymphalidae			
8	*Vanessa cardui*	Painted Lady	*Artemisia sp* *Bluema sp* *Debregeasia sp* *Gnaphalium sp*	Herb Herb Shrub Herb
9	*Tirumala septentrionis septentrionis*	Blue Tiger	*Calotropis gigantea* *Hoya sp*	Shrub Climber
	Hesperiidae			
10	*Hasora chromus chromus*	Common Banded Awl	*Ricinus communis*	Shrub
11	*Tagiades cohaerens cynthia*	Water Snow Flat	*Dioscorea sp* *Smilax sp*	Climber Climber
12	*Notocrypta curvifascia curvifascia*	Restricted Demon	*Costus speciosus* *Curcuma sp* *Zingiber montanum*	Herb Herb Herb

S. No.	Family / Scientific Name	Common Name	Larval Host Plant	Habit
13	*Notocrypta sp.*	Grass Demon	*Zingiber sp* *Curcuma sp*	Herb Herb

Annexure 7.5 : Cavity / Hole Nesting Birds recorded in the Etalin HEP Study Area, and Structural details on Nest Boxes

S.No.	*Scientific Name*	English Name	P/S Cavity Nesters	Nest Box Size	Hole Diameter in cm
1	*Aegithalos concinnus*	Black-throated Tit	S	Small	4-5
2	*Aegithalos iouschistos*	Black-browed Tit	S	Small	4-5
3	*Buceros bicornis*	Great Hornbill	S	Very Large	20-25
4	*Falco tinnunculus*	Common Kestrel	S	Large	12-15
5	*Falco severus*	Oriental Hobby	S	Large	12-15
6	*Copsychus saularis*	Oriental Magpie Robin	S	Small	4-5
7	*Melanochlora sultanea*	Sultan Tit	S	Small	4-5
8	*Parus monticolus*	Green-backed Tit	S	Small	4-5
9	*Parus spilonotus*	Yellow-cheeked Tit	S	Small	4-5
10	*Picumnus innominatus*	Speckled Piculet	P	Small	3
11	*Dendrocopos canicapillus*	Grey-capped Pygmy Woodpecker	P	Small	3
12	*Gecinulus grantia*	Pale-headed Woodpecker	P	Medium	7-8
13	*Micropternus brachyurus*	Rufous Woodpecker	P	Medium	7-8
14	*Blythipicus pyrrhotis*	Bay Woodpecker	P	Large	10
15	*Dendrocopos darjellensis*	Darjeeling Pied Woodpecker	P	Small	5
16	*Picus canus*	Grey-headed Woodpecker	P	Large	10
17	*Chrysophlegma flavinucha*	Greater Yellow-naped Woodpecker	P	Large	10
18	*Picus chlorolophus*	Lesser Yellow-naped Woodpecker	P	Medium	7-8
19	*Psilopogon virens*	Great Barbet	P	Medium	7-8
20	*Psilopogon asiaticus*	Blue throated barbet	P	Small	4-5
21	*Psilopogon lineatus*	Lineated Barbet	P	Medium	6-7
22	*Psilopogon franklinii*	Golden-throated Barbet	P	Small	6-7

S.No.	*Scientific Name*	English Name	P/S Cavity Nesters	Nest Box Size	Hole Diameter in cm
23	*Sitta himalayensis*	White-tailed Nuthatch	P	Small	3
24	*Sitta frontalis*	Velvet-fronted Nuthatch	P	Small	3
25	*Glaucidium brodiei*	Collared Owlet	S	Medium	7-8
26	*Glaucidium cuculoides*	Asian Barred Owlet	S	Medium	7-8
27	*Otus spilocephalus*	Mountain Scops Owl	S	Medium	8-9
28	*Otus bakkamoena*	Collared Scops Owl	S	Medium	7-8
29	*Acridotheres tristis*	Common Myna	S	Medium	7-8
30	*Sturnia malabarica*	Chestnut-tailed Starling	S	Small	4-5
31	*Harpactes erythrocephalus*	Red-headed Trogon	S	Medium	8-9
32	*Harpactes wardi*	Ward's Trogon	S	Medium	8-9

P/S Cavity Nesters: Primary / Secondary

Size of Nest Box: Small - height / depth = 20-22 cm, Length & width = 15 cm; Medium - height / depth =35-37 cm length & Width = 25 cm; Large - height /depth = 45 cm, Length & width = 35 cm; Very Large – height / depth = 75 cm, length / width = 50cm

https://www.google.co.in/search?q=Nest+boxes+for+birds&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjag_qIvILdAhUGTI8KHfL7AZ8Q_AUICigB&biw=1366&bih=635#imgrc=R7lwoniLoc_vXM:

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Annexure 7.6: List of Fruiting Plant Species recommended as part of Habitat Restoration / Afforestation

S.No.	Scientific Name	Habit	Common Name
1.	*Tetrameles nudiflora*	Tree	False hemp tree
2.	*Altingia excelsa noronha*	Tree	

S.No.	Scientific Name	Habit	Common Name
3.	*Calamus erectus*	Climber	
4.	*Calamus flagellum*	Climber	
5.	*Calamus floribundus*	Climber	
6.	*Calamus inermis*	Climber	
7.	*Calamus leptospadix*	Climber	
8.	*Michelia champaca*	Tree	Champa
9.	*Kydia calycina*	Tree	Kydia
10.	*Amoora wallichii*	Tree	Amari
11.	*Dysoxylum hamiltonii*	Tree	
12.	*Dysoxylum mollissimum*	Tree	Red bean
13.	*Toona hexandra*	Tree	Red cedar/Toon
14.	*Artocarpus chaplasha*	Tree	
15.	*Ficus cunia*	Tree	Drooping fig
16.	*Ficus roxburghii*	Tree	Elephant ear fig
17.	*Ficus semicordata*	Tree	Drooping fig
18.	*Morus laevigata*	Tree	Himalayan Mulberry
19.	*Ficus heterophylla*	Tree	East Indian hairy fig
20.	*Ficus lacor*	Tree	
21.	*Ficus cyrtophyllat*	Tree	
22.	*Ficus hookeriana*	Tree	
23.	*Maclura cochinchinensis*	Climber	Cockspur thorn
24.	*Knema cinerea*	Tree	Wild nutmeg
25.	*Psidium guajava*	Tree	Guava
26.	*Syzygium formosum*	Tree	
27.	*Rubus rosifolius*	Shrub	Roseleaf bamble
28.	*Rubus neives*	Climber	Ceylon rasberry
29.	*Rubus ellipticus*	Shrub	Golden Himalayan rasberry
30.	*Rubus foliolosus*	Shrub	
31.	*Rubus burkillii*	Shrub	
32.	*Rubus parviflora*	Climber	Thimbleberry
33.	*Citrus lemon*	Tree	Lemon
34.	*Murraya paniculata*	Tree	Kamini
35.	*Musa spp.*	Tree	Snow/Rock Banana

S.No.	Scientific Name	Habit	Common Name
36.	*Rhaphitophora decursiva*	Climber	Creeping Philodendron
37.	*Boehmeria longifolia*	Shrub	
38.	*Boehmeria macrophylla*	Shrub	False nettle
39.	*Bischofia javanica*	Tree	Bishop wood
40.	*Castanopsis* spp.	Tree	chinquapin or chinkapin
41.	*Lithocarpus dealbatus*	Tree	
42.	*Lithocarpus pachyphyllus*	Tree	Thick leaved oak
43.	*Lithocarpus fenestratus*	Tree	
44.	*Lithocarpus falconeri*	Tree	
45.	*Lithocarpus elegans*	Tree	
46.	*Lithocarpus listeria*	Tree	
47.	*Poilokospermum lanceolatum*	Climber	
48.	*Debregeasia* spp.	Shrub	Wild rhea
49.	*Oreocnide* spp.	Shrub	Wild rhea
50.	*Phoebe* spp.	Tree	
51.	*Cinnamomum* spp.	Tree	Cinnamon
52.	*Alseodaphne* spp.	Tree	Alseodaphne
53.	*Lithocarpus* spp.	Tree	Stone oak
54.	*Sauraria nepalensis*	Tree	
55.	*Canarium strictum*	Tree	Black dhup or Black dammar
56.	*Dillenia indica*	Tree	Elephant apple or chulta
57.	*Macaranga denticulate*	Tree	
58.	*Duabanga grandiflora*	Tree	Duabanga

Annexure 7.7. Suggested Native Tree species of Project Study Area for Restoration

S.No	Species Name	Habit	S.No	Species Name	Habit
1	*Boehmeria longifolia*	*S*			
2	*Boehmeria macrophylla*	*S*	14	*Milletia pachycoyea*	*C*
3	*Chloranthus elatior*	*S*	**15**	*Ostodes paniculate*	*T*
4	*Clematis acuminata*	*C*	16	*Periploca calophylla*	*C*
5	*Debregeasia* sp.	*S*	17	*Phlocanthus curviflorus*	*S*

6	*Engelhardtia spicata*	T	18	*Piper clerki*	C
7	*Ficus semicordata*	*T*	19	*Rhaphitophora decursiva*	C
8	*Kydia calycina*	*T*	20	*Rhynchotechum ellipticum*	S
9	*Laportea* sp.	*S*	21	*Sambucus hookeri*	S
10	*Lithocarpus fenestratus*	*T*	22	*Smilax* sp.	C
11	*Lithocarpus pachyphyllus*	T	24	*Stephania* sp.	C
12	*Litsea cubeba*	*T*	25	*Terminalia myocarpa*	*T*
13	*Macaranga denticulata*	T	26	*Tetrastigma affine*	C
T-tree, S-shrub, C=Creeper					

Annexure 7.8: List of Orchids, Pteridophytes and Lichens of the Etalin HEP Study Area (secondary sources) and species reported during the Present Biodiversity Survey *

LIST OF ORCHIDS – Orchidaceae			
S.No	**Species name**	**S.No**	**Species name**
1	*Aerides multiflora*	18	*Dendrobium lituiflorum*
2	*Arundina graminifolia*	19	*Goodyera procera* *
3	*Bulbophyllum affine* *	20	*Eria flava*
4	*Bulbophyllum careyanum*	21	*Lepanthes pedunculata*
5	*Bulbophyllum cauliflorum*	22	*Liparis delicatula* *
6	*Bulbophyllum guttulatum*	23	*Phaius flavus*
7	*Calanthe griffithii*	24	*Pholidota imbricata*
8	*Coelogyne barbata*	25	*Rhynchostylis retusa*
9	*Coelogyne corymbosa*	26	*Spiranthes sinensis*
10	*Cymbidium aloeifolium* *	27	*Anoectochilus brevilabris* *
11	*Cymbidium eburneum*	28	*Calanthe plantaginea* *
12	*Cymbidium elegans*	29	*Coelogyne stricta* *
13	*Cymbidium cyperifolium*	30	*Cymbidium lancifolium* *
14	*Cymbidium iridioides*	31	*Dendrobium transparens* *
15	*Dendrobium densiflorum*	32	*Epipogium roseum* *
16	*Dendrobium hookerianum*	33	*Tropidia curcugiloides* *
17	*Dendrobium moschatum*	34	*Vanda cristata* *
LIST OF PTERIDOPHYTES			
	Family & Species name		**Family & Species name**
1	**Adiantaceae**	17	*Lepisorus nudus*
1	*Adiantum caudatum*	18	*Microsorum membranaceum*

2	*Adiantum philippense*	19	*Microsorum punctctum*
2	**Angiopteridaceae**	20	*Microsorum pteropus*
3	Angiopteris evecta	21	*Polypodium amoenum*
3	**Aspleniaceae**	22	*Phymatopteris ebenipes* *
4	*Asplenium nidus*	23	*Phymatosorus cuspidatus* *
4	**Cyatheaceae**	**11**	**Lycopodiaceae**
5	*Cyathea gigantea* *	24	*Lycopodium clavatum*
6	*Cyathea spinulosa* *	**12**	**Nephrolepdaceae/Davalliaceae**
5	**Gleichiaceae**	25	*Nephrolepis cordifolia*
7	*Dicranopteris linearis*	26	*Nephrolepis auriculata* *
6	**Athyriaceae**	**13**	**Cryptogrammaceae**
8	*Diplazium bentamense*	27	*Onychium siliculosum*
9	*Diplazium sp.* *	**14**	**Aspidiaceae**
7	**Polypodiaceae**	28	*Polystichum aculeatum* *
10	*Drymoglossum heterophyllum*	**15**	**Thelypteridaceae**
11	*Dryoathyrium boryanum*	29	*Pronephrium affine*
8	**Equisetaceae**	**16**	**Hypoleppidaceae/Dennstaedtiaceae**
12	*Equisetum ramossimum* *	30	*Pteridium aquilinum* *
9	**Gleicheniaceae**	**17**	**Pteridaceae**
13	*Gleichenia longissima*	31	*Pteris quadriaurita*
10	**Polypodiaceae**	32	*Pterisvittata*
14	*Arthromeris wallichiana*	**18**	**Selaginellaceae**
15	*Lepisorus excavata* *	33	*Selaginella indica* *
16	*Lepisorus sordidus* *		
	LIST OF LICHENS		
1	**Coccocarpaceae**	8	**Pilocarpaceae**
	Coccocapia		*Byssolma*
2	**Collemataceae**	9	**Pyrenulaceae**
	Leptogium		*Anthracothecium*
3	**Cryptotheciaceae**	10	**Rhizocarpaceae**
	Cyptothecia		*Rhizocarpon*
4	**Graphidaceae**	11	**Teloschistaceae**
	Phaeographina		*Brigantiaea*
5	**Letrouitiaceae**	12	**Thelotremataceae**

	Letrouitia		*Diplochistes*
6	**Parmeliaceae**	13	**Usneaceae**
	Parmelina wallichaina		*Bryonia*
7	**Physciaceae**	14	**Usneaceae**
	Physcia		*Usnea baileyi**
	*** Species Reported during this survey in the project area**		

Annexure I

GOVERNMENT OF ARUNACHAL PRADESH
DEPARTMENT OF ENVIRONMENT & FOREST
ITANAGAR.

NO.FOR-279/CONS/2010/Vol-I / 131-40 Dated Itanagar, the 23rd June 2017

To

The Director,
Wildlife Institute of India (WII)
Chandrabani, Mehu Wala Mafi,
Uttarakhand-248007

Sub: To conduct multiple seasonal replicate study for the preparation of Wildlife & Biodiversity Management plan.

Sir,

The 'Forest Advisory Committee' (FAC), MoEF&CC, Govt. of India, in its meeting held on 28/02/2017 recommended to conduct a multiple seasonal replicate study on Biodiversity Assessment of the catchment area of 3097 MW, Etalin Hydro Electric Project in Dibang Valley district of Arunachal Pradesh. The recommendation of FAC in respect of Etalin Hydro Electric Project is enclosed herewith for your ready reference. The minutes of meeting taken by PCCF (WL &BD) and Chief Wildlife Warden, Arunachal Pradesh with user agency in this respect is also enclosed for your reference.

You are requested to conduct multiple seasonal replicate study of the catchment area of aforementioned Hydro Electric Project and prepare and submit Wildlife & Biodiversity plan. All expenditure in respect of the study shall be borne by user agency i.e. M/s Etalin HEP Company Ltd. - Gurgaon.

Enclo: As above.

Yours faithfully,

(Ishwar Singh), IFS
APCCF & Nodal Officer (FCA)

Copy to:-

1. The PCCF (WL &BD) & Chief Wildlife Warden, A.P. for information please.
2. IGF(C), Ministry of Environment & Forest, Govt. of India for information please.
3. Addl. PCCF (Central), Eastern Regional office of MoEF&CC, GOI Shillong
4. M/s Etalin Hydro Electric Power Company Ltd. –Gurgaon-122001 (Haryana), for information and with the request to take up the issue with Wildlife Institute of India on mutually agreed terms and conditions. The entire expenditure for conducting study and preparation of Wildlife Management Plan shall be borne by user agency.

(Ishwar Singh), IFS
APCCF & Nodal Officer (FCA)

WILDLIFE INSTITUTE OF INDIA CHANDRABANI, DEHRADUN

Etalin Hydro Electric Power Company Ltd.

- 19 -

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

No. WII/DWII/Misc/03/2014

18 July, 2017

To,

Shri Ishwar Singh
APCCF & Nodal Officer (FCA)
Department of Environment & Forest,
Government of Arunachal Pradesh,
Itanagar

Sub.: Technical and Financial Proposals to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh – reg.

Ref.: **Your letter No. 279/CONS/2010/Vol-I/836-40 dated 23 June, 2017**

Sir,

With reference to the above, I am pleased to submit the Technical and Financial proposals to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh for your kind perusal and further necessary action, please.

It is stated that Wildlife Institute of India may not be able to accept the funding for this study, which will be conducted based on the direction of Forest Advisory Committee (FAC), MoEFCC, Government of India, directly from the project proponent i.e. M/s Etalin, HEP Company Ltd., Gurgaon. In view of the above, it is stated that administrative and financial approval for this study may kindly be provided by your office along with the funds as per the financial proposal enclosed.

Thanking you.

Yours faithfully,

[Dr. V.B. Mathur]
Director

Encl.: As above

Cc.:
1. **PPS to DGF & SS, MoEFCC, New Delhi**
2. **The PCCF (WL & BD) & Chief Wildlife Warden, Arunachal Pradesh.**
3. **The IGF (FC), MoEFCC, New Delhi**
4. **Addl. PCCF (Central), Eastern Regional Office of MoEFCC, Shillong**
5. **Dean, Wildlife Institute of India**
6. **M/s Etalin, HEP Company Ltd., Gurgaon- 122 001 (Haryana)**

पत्रपेटी सं0 18, चन्द्रबनी, देहरादून – 248001, उत्तराखण्ड, भारत
Post Box No. 18, Chandrabani, Dehradun – 248001, Uttarakhand, INDIA
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EPABX : +91-135-2640114, 2640115, 2646100; **Fax :** 0135-2640117;
ई–मेल / **E-mail:** wii@wii.gov.in, वेब / **website:** www.wii.gov.in

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

No. WII/DWII/Misc/03/2014

28 July, 2017

To,

Shri Ishwar Singh
APCCF & Nodal Officer (FCA)
Department of Environment & Forest,
Government of Arunachal Pradesh,
Itanagar

Sub.: Technical and Financial Proposals to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh – reg.

Ref.: (i) Your letter No. 279/CONS/2010/Vol-I/836-40 dated 23 June, 2017
(ii) WII letter of even number dated 18 July, 2017

Sir,

With reference to the above, I would request you to kindly grant necessary sanction and arrange to release the funds for this study so that work can be initiated at the earliest.

Thanking you.

Yours faithfully,

[Dr. V.B. Mathur]
Director

Cc.:
1. **PPS to DGF & SS, MoEFCC, New Delhi**
2. **The PCCF (WL & BD) & Chief Wildlife Warden, Arunachal Pradesh.**
3. **The IGF (FC), MoEFCC, New Delhi**
4. **Addl. PCCF (Central), Eastern Regional Office of MoEFCC, Shillong**
5. **Dean, Wildlife Institute of India**
6. **M/s Etalin, HEP Company Ltd., Gurgaon- 122 001 (Haryana)**

Post Box No.18, Chandrabani, Dehradun - 248001. India
EPABX: +91-135 - 640111 to 640115 640990; FAX: 640117; GRAM: WILDLIFE
E-Mail: wii@wii.gov.in

F. No. 8-20/2014-FC
Government of India
Ministry of Environment, Forests and Climate Change
(Forest Conservation Division)

Indira Paryavaran Bhawan,
Aliganj, Jorbagh Road,
New Delhi- 110003
Dated: 25th September, 2017

OS
03/10/17

To,

The Director,
Wildlife Institute of India (WII)
Dehradun.

Sub: Diversion of 1346.561 ha of forest land for construction of Etalin Hydro Electric Project (3097 MW) in Dibang Valley District of Arunachal Pradesh by M/s Etalin Hydro Electric Power Company Limited, Arunachal Pradesh.

Sir,

I am directed to inform that the above subject proposal was considered by the FAC in its meeting held on 28.02.2017 and the FAC, after detail deliberation, ***recommended conducting multiple seasonal replicate studies on biodiversity assessment by an internationally credible institute as the current study (EIA) is completely inadequate in this regard***. Accordingly, the State Government was requested vide this Ministry's letter of even number dated 28.03.2017 to furnish the detailed reply including study report as sought by the FAC.

The State Government had intimated that the Director, WII, Dehradun was requested to conduct multiple seasonal replicate study for the preparation of Wildlife & Biodiversity Plans and the WII submitted a proposal to conduct the aforementioned study and requested Government of Arunachal Pradesh to give administrative & financial approval along with the provisions of funds by the State Government.

It is further informed that this matter was also taken up in a meeting chaired by Secretary, DoNER, GoI on 19.09.2017. He had requested this Ministry to take up the matter with WII to conduct the study at the earliest.

Taking into consideration the above facts, it has now been decided in the Ministry that Wildlife Institute of India (WII) to conduct the study on mutually agreed terms and conditions with the user agency and WII and the report of the said study may be submitted to the State Government/ user agency for further consideration.

The cost of the study will be borne by the user agency as demanded by WII for the specified study.

Yours faithfully,

Sh. Lekhanath
Pls scan & send to all team members (+ be provided by Sh. Rajeev Rajput)
Dr. G.V. / Pls discuss

(Sandeep Sharma) 26.9.17
Assistant Inspector General of Forests

Copy to:

1. The Principal Secretary (Forests), Government of Arunachal Pradesh, Itanagar.
2. The Principal Chief Conservator of Forests, Government of Arunachal Pradesh, Itanagar.
3. The Nodal Officer, O/o the PCCF, Government of Arunachal Pradesh, Itanagar.
4. User Agency.
5. Monitoring Cell, FC Divisions, MoEF&CC.
6. Guard File

(Sandeep Sharma) 26.9.17
Assistant Inspector General of Forests

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

No. WII/ ESM/GGV/Etalin 13 October 2017

To,

Shri Anil Dhar
Associate Vice President (Hydro)
Etalin Hydro Electric Company Limited,
Flat No. 3, First Floor, Tashi Yang Apartment,
Prem Norbu Khirmey Building,
MOWB II, Opposite to Office of Urban Development,
Itanagar, Arunachal Pradesh – 791 111
Email: anil.dhar@jindalsteel.com

Sub.: Technical and Financial Proposals to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh – reg.

Ref: MoEFCC Letter F.No. 8-20/2014-FC dated 25 September 2017

Sir,

With reference to the above, I am pleased to submit the Technical and Financial proposals to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh for your kind perusal and further necessary action, please. The MoEFCC has accorded the administrative and financial approvals to WII for conducting the study. The cost of the study will be borne by the Etalin Hydro Electric Power Company Limited. The Institute's Bank details for e-transfer of the funds is given below and the release of funds may be expedited so that the work can be initiated at the earliest. A draft MoU may be sent which can be duly signed by competent authorities of WII and EHEPCL.

Bank Name	Union Bank of India
Beneficiary	Director, Wildlife Institute of India, Dehradun
Account Number	518502010000001
IFSC Code	UBIN0551856
Swift Code	UBININBBDER
Purpose	Wildlife Conservation Plan for the impact zone of Etalin HEP

Thanking you,

Yours faithfully,

[Dr. V.B. Mathur]
Director

Encl: As above

Cc.: 1. Etalin Hydro Electric Power Company limited, 5th Floor, Tower – B, Jindal Centre, Plot No. 2, Sector – 32, Gurgaon- 122 001 (Haryana). Email: anil.dhar@jindalsteel.com, jagdish.soni@jindalsteel.com
2. PPS to DGF & SS, MoEFCC, New Delhi. Email: dgfindia@nic.in, siddhantadas@gmail.com
3. The PCCF (WL & BD) & Chief Wildlife Warden, Arunachal Pradesh. Email: pccfcwlw-arn@nic.in, pccfwildlife@gmail.com
4. The IGF (FC), MoEFCC, New Delhi. Email: igfwl-mef@nic.in, soumitra444@rediffmail.com

पत्रपेटी सं0 18, चन्द्रबनी, देहरादून – 248001, उत्तराखण्ड, भारत
Post Box No. 18, Chandrabani, Dehradun – 248001, Uttarakhand, INDIA
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ई–मेल / E-mail: wii@wii.gov.in, वेब / website: www.wii.gov.in

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

No. WII/ ESM/GGV/Etalin 22 November, 2017

To,

Shri Anil Dhar
Associate Vice President (Hydro)
Etalin Hydro Electric Power Company limited,
5th Floor, Tower – B, Jindal Centre, Plot No. 2, Sector – 32, Gurgaon- 122 001 (Haryana)
Email: anil.dhar@jindalsteel.com

Sub.: Memorandum of Understanding between Etalin Hydro Electric Power Company Limited and Wildlife Institute of India to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh – reg.

Ref: Email from Dr. J. K. Soni, Group Executive Vice President (Environment), Jindal Steel & Power Limited dated 21 November, 2017

Sir,

With reference to the above, I am enclosing herewith 2 signed copy of the Memorandum of Understanding between Etalin Hydro Electric Power Company Limited and Wildlife Institute of India to conduct multiple seasonal replicate study for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP, Dibang Valley District, Arunachal Pradesh with an overall budget of Rs. 170.36 lakhs. It is requested that the MoU may be signed at your end and 1 copy may be sent to us for our records.

In order to facilitate WII for conducting the study it is requested that the first instalment representing 35% of the total budget i.e. Rs. 59.63 Lakhs may kindly be transferred. The Institute's Bank details for e-transfer of the funds is given below:

Bank Name	**Union Bank of India**
Beneficiary	Director, Wildlife Institute of India, Dehradun
Account Number	518502010000001
IFSC Code	UBIN0551856
Swift Code	UBININBBDER

Thanking you,

Yours faithfully,

[Dr. V.B. Mathur]
Director

Encl: As above

Cc.: 1. Dr. J. K. Soni, Group Executive Vice President (Environment), Jindal Steel & Power Limited, NTH Building, 3rd Floor, Qutub Institutional Area, A/2 Saheed Jeet Singh Marg, New Delhi-110067. Email: jagdish.soni@jindalsteel.com
2. PPS to DGF & SS, MoEFCC, New Delhi. Email: dgfindia@nic.in, siddhantadas@gmail.com
3. The PCCF (WL & BD) & Chief Wildlife Warden, Arunachal Pradesh. Email: pccfcwlw-arn@nic.in, pccfwildlife@gmail.com
4. The IGF (FC), MoEFCC, New Delhi. Email: igfwl-mef@nic.in, soumitra444@rediffmail.com

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ई–मेल / E-mail: wii@wii.gov.in, वेब / website: www.wii.gov.in

MEMORANDUM OF UNDERSTANDING

Between

Etalin Hydro Electric Power Company Limited

And

Wildlife Institute of India

This Memorandum of Understanding (MOU) is entered into on 22 Day of November 2017 between the following parties:

Wildlife Institute of India (WII) having their registered & Head Office at Post Box No. 18, Chandrabani, Dehradun – 248001, Uttarakhand, India, which expression shall unless repugnant to the context thereof mean and include its successors and assigns of the FIRST PART (here-in-after to be called 'THE FIRST PARTY' or 'WII') of the one part.

And

Etalin Hydro Electric Power Company Limited, 5th Floor, Tower-B, Jindal Centre, Plot No. 2, Sector-32, Gurgaon – 122001, Haryana, India, which expression shall unless repugnant to the context thereof mean and include its successors and assigns of the SECOND PART (here-in-after referred as 'THE SECOND PARTY' or 'EHEPCL') of the other part.

Hereinafter, WII and EHEPCL individually shall be referred as Party and jointly as Parties.

WHEREAS the first party in under the aegis of Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India, as an Autonomous Institute to provide services in the area of Wildlife for development of the Hydro Power Projects.

AND WHEREAS the second party is engaged in the development of Etalin HE Project in Dibang Valley District of Arunachal Pradesh, India.

AND WHEREAS EHEPCL desires availing the services of WII for conducting multiple seasonal replicate studies for the preparation of Wildlife Conservation Plan for the impact zone of Etalin HEP.

AND WHEREAS WII is agreed for providing the above services within its area of expertise to EHEPCL.

Now this MOU witnesses as follows:

1. This Memorandum of Understanding provides broad understanding to mutually engage into the specific assignment based on the needs of the EHEPCL.

2. Whenever solicited, WII shall render its expertise in the best possible manner as per the needs of EHEPCL at mutually agreed commercial terms.

3. WII shall ensure confidentiality and non-disclosure of any data or information pertaining to EHEPCL or any of its projects.

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Etalin Hydro Electric Power Company Ltd.

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4. Both EHEPCL and WII being committed to this Memorandum of Understanding may use the identity of each other in various forms of its communications.

5. This Memorandum of Understanding shall be effective for a period of one year, i.e., up to 30/11/2018 and shall be mutually agreed for renewal of the same.

6. In the event of any difference of interpretation of any of the terms of this Memorandum of Understanding, the same shall be resolved through mutual discussions.

7. All the disputes or differences arising out of this MOU shall be subject to the exclusive Jurisdiction of Civil Courts of Delhi only.

Project Background and Scope

The Etalin Hydro Electric Power Company Limited (EHEPCL) is developing 3097 MW Etalin Hydroelectric Power Project (HEPP) in Dibang Valley district of Arunachal Pradesh. The project envisages utilization of waters of Dri and Tangon rivers for hydropower generation. The two rivers are tributaries of Dibang River and confluence near Etalin village.

This project envisages construction of 2 dams namely (i) a 101.5 m high dam on Dri river near Yuron village about 22 km from Etalin and (ii) a 80 m high dam on 16 Tangon river about 800 m downstream of Anon Pani confluence with Tangon river (from the deepest foundation) with an Installed Capacity of 3,097 MW HEP. The Dri and Tangon Rivers are tributaries of Dibang River. The total land requirement for the project is 1,155.11 ha. The submergence area is 119.44 ha. An underground powerhouse is proposed with 10 units of 307 MW each. In order to utilize the releases of flow for sustenance of aquatic life, a dam - toe powerhouse with 19.62 MW capacity on Dri diversion and dam-toe powerhouse with 7.40 MW capacity on Tangon diversion have been proposed. A total of 18 villages consisting of 285 project affected families (PAFs) will be affected by the proposed project. The estimated cost of the project is Rs. 25,296.95 crores and it is proposed to be completed in 7 years.

WII proposes this study with the primary scope of assessing the biodiversity with respect HEP and its impacts, both through field surveys as well as through review of literatures and to suggest measures for species conservation and management. In this connection, status and distribution of certain rare, endangered and threatened faunal species which might use riverine and adjoining forests as migration corridors needs to be assessed on a priority basis so as to determine the impacts of hydropower project and to develop/evolve appropriate wildlife management plan. Special attention will be paid with respect to habitats of tigers.

Objectives

As per the advice of 'Forest Advice Committee (FAC)', MoEF&CC, Government of India has requested WII to conduct this multiple seasonal replicate study on biodiversity assessment of the catchment area of the Etalin HEP to develop a Wildlife Conservation Plan for the impact zone of the Etalin HEP. In this context, a study is proposed with following objectives;

- To determine the current status of wildlife habitat and distribution pattern of plants, mammals, birds, herpetafauna and fish within the impact zone of the Etalin Project area covering all seasons.
- Status and distribution pattern of certain 'Rare, Endangered and other Threatened Species (RET) in the impact of zone of HEP.

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- Identification of critical habitats, wildlife corridors and migratory paths of RET species in the impact zone of the project. Habitat and migratory path of tigers will be given special attention.

- Develop a Wildlife Management Plan for the impact zone with respect to potential impact of HEP.

Methodology

The methodology planned is briefed below. Detailed methodology is outlined in the Concept Proposal enclosed to this MOU as **Annexure – I.**

- Land use / land cover types in Project Site
- Identification of corridors and migratory path of important wildlife within the impact zone
- Determination of distribution and relative abundance of mammalian species (Interview based information / trial walk / line transect / pellet count / camera trapping)
- Measurement of vegetation attributes
- Assessment of avian fauna in the impact zone of the Project
- Assessment of fish and their habitats
- Fish sampling
- Identification and assessment of "Rare, Endangered and other Threatened" species

Deliverables

Following the field surveys and collection of primary field data coupled with secondary information from available literatures, a detailed Wildlife Management Plan will be prepared.

Work Plan

Major Activities	Period
Survey planning & designing, procuring entry permits and logistics, engaging project staff	Nov' 2017
Field Data collection	Dec' 2017 to April' 2018
Report writing & information dissemination	May' 2018 to Sept' 2018

Budget

Total cost of the study is Rs. 170.36 Lakhs (plus GST, as applicable). This cost comprises of the following components -

- **Technical Manpower** - **Rs. 110.70 Lakhs**
  (Faculty / External Experts / Project Staff / Field Assistants)

- **Field Studies** - **Rs. 14.44 Lakhs**
  (Hiring of vehicles / Field Camping charges / Travel to field sites / Accommodation)

- **Field Equipment / Report Printing** - **Rs. 23.00 Lakhs**
  (Camera traps / laptop / GPS / Binocular / etc)

- **Institutional Charges (@15%)** - **Rs. 22.22 Lakhs**

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One vehicle in field along with driver, POL & maintenance, boarding and lodging for the team while in field and 5 local field staffs shall be provided by EHEPCL.

Terms of Payment with tentative timelines

Advance	35%	Rs. 59.63 Lakhs	Nov' 2017
On Mobilization of Field Staff with equipment for Field Studies	30%	Rs. 51.11 Lakhs	Dec' 2017
Submission of Draft Report	25%	Rs. 42.59 Lakhs	July' 2018
Submission of Final Report	10%	Rs. 17.03 Lakhs	Sept' 2018

Payments shall be released against each milestone within 30 days of submission of invoice/s, duly approved by EHEPCL.

For effective implementation and monitoring of the solicitation of expertise as envisaged in the MOU, Director, WII or an authorized representative shall be the Nodal Officer on behalf of 'WII', Group Executive Vice President (Environment) or an authorized representative shall be the Nodal Officer on behalf of 'EHEPCL'.

In WITNESS WHEREOF, the parties hereto have caused this agreement to be made in English and executed by their respective duly authorized representatives of the day and the year first above written.

Signed for and on behalf WII

Name Dr V B Mathur
Designation Director, WII

डा. वि.बि. माथुर/Dr. V.B. Mathur
निदेशक/Director
भारतीय वन्यजीव संस्थान
WILDLIFE INSTITUTE OF INDIA
देहरादून/Dehradun

Witness

1. Dr. Gopi. G. V.

2.

Signed for and on behalf EHEPCL

Name SUNIL AGRAWAL
Designation AVP

Etalin Hydro Electric Power Company Ltd.

1. (ANIL AMAR)

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भारतीय वन्यजीव संस्थान
Wildlife Institute of India

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