

# RAPID BIODIVERSITY SURVEY REPORT – VII

*MONITORING OF BIODIVERSITY  
(REVISIT STUDY)*



**Sikkim Biodiversity Conservation and Forest Management Project (SBFP)**

Forest and Environment Department

**Government of Sikkim**

**2020**



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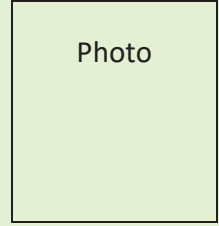
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## MESSAGE

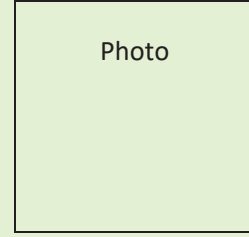
Prem Singh Tamang  
Chief Minister of Sikkim



Shri Karma Loday Bhutia

## FOREWORD

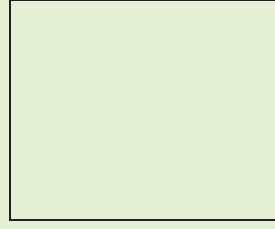
Shri Karma Loday Bhutia  
Minister  
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Mines and Geology, Science and Technology  
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Shri M. L. Srivastava (IFS)

## **PREFACE**

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**ACKNOWLEDGEMENT**

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## INTRODUCTION

Resurveying and seasonal variation study provides a unique opportunity to estimate vegetation and its changes over time period. Previous plot area describes in detail the variation in vegetation and species composition of a certain vegetation type or area, and to resurvey vegetation on formerly surveyed plots may provide vegetation shifts over time of that particular location. Resurveying of earlier vegetation data may also provide unique insights into vegetation changes in relation to environmental change over time period. The wealth of earlier plot data available represents a valuable source for understanding long-term vegetation dynamics and how vegetation responds to different climatic conditions.

The aim of revisit study was to develop baseline information on key biological elements in forest, alpine, freshwater and agro-ecosystem for monitoring and evaluation of the impacts of forest and biodiversity management. To record species which may have been missed during previous survey, also to identify critical areas that requires immediate protection. to monitor any changes in vegetation composition over a period. Data gathered after the resurvey possess a better description of the characteristics of the general vegetation involved in the study and are near to the exact attributes.

It also provides a basis for evaluating their responses to disturbances, and the success of actions taken to conserve or recover biodiversity.

## Monitoring of Biodiversity (Revisit)

Biodiversity Conservation which aims to enhance the global, social and economic value of biodiversity and improve livelihoods in and around protected areas (PAs), buffer zones and reserve forests. It seeks to achieve this objective through the establishment and implementation of sound management plans and the dissemination of biodiversity information for promoting public awareness on the significance of biodiversity.

1. It is one of the components of JICA-assisted Sikkim Biodiversity Conservation and Forest Management Project, having different subcomponents including Inventory and Monitoring of Biodiversity; the basic objectives of which are:
2. To develop baseline information on key biological elements in forest, alpine, freshwater and agro-ecosystem for monitoring and evaluation of the impacts of forest and biodiversity management.
3. To identify critical areas that requires immediate protection. To achieve these objectives, Rapid Biodiversity Survey will be conducted by laying 1000 random plots in whole of the state of Sikkim covering all the four ecosystems. Simultaneously, 300 additional plots in the known biodiversity hotspot of the state will be laid covering all the four ecosystems. The output of the same will be:
4. Generation of biodiversity information on four ecosystems to be used in the production of thematic maps for management so that key areas are protected;
5. Stored at the GIS/RS laboratory.

Rapid biodiversity Survey (RBS) was carried out in different parts of Sikkim. In the first phase, protected areas were targeted for carrying out the survey for which an inventory and monitoring for the same has been fulfilled and published in Rapid Biodiversity Survey Reports- I and Rapid Biodiversity Survey – II is the series of RBS I highlighting the analysis study. Rapid Biodiversity Survey - III highlights the inventory of biodiversity of the remaining Protected Areas of Sikkim including the published research papers and articles. Inventory of Biodiversity-Rapid Biodiversity Survey - IV, Rapid Biodiversity Survey - V is a compilation of the analysis report of some of the Reserve Forests. Rapid Biodiversity Survey – VI is a compilation of inventory and monitoring of biodiversity of Protected Areas of North Sikkim. This Rapid Biodiversity Survey – VII is a compilation of revisit studies to monitor changes in vegetation composition in the forest areas of Sikkim.

### MATERIALS AND METHODS

Prior to field survey, the entire area (vegetation map) of the present study was prepared into 0.5 km X 0.5 km grids in GIS laboratory. Based on this, each vegetation/forest types and forest density on the total grids in the specific vegetation type was sampled for the rapid biodiversity assessment (flora and fauna) inventorization. The selection of grids was done by taking the following aspects of consideration:

1. Forest density and forest cover (dense & moderate forest).

## 2. Compartments of the forest.

### **FLORA**

The sampling plot of 10 X 10 m was laid, depending upon the site feasibility. Within the main plot, all the standing tree species were enumerated; and circumference at breast height (CBH) for total basal area at 1.37m from the ground was measured by using measuring tape. Basal area (m<sup>2</sup> / ha) was used to determine the relative dominance of a tree species. Within the subplots, one quadrat of 5m X 5m was laid for recording the sapling (no. of species and its height) and shrub percentage. Within this, 1m X 1m quadrat was laid in 4 corners and 1 point at centre for seedling species. The same 1m X 1m quadrat was used for recording the herb percentage in the area. The location and altitude of the plots were recorded by calibrating the global positioning system (GPS; Garmin eTrex) and the humus depth was measured with the help of measuring scale. Plant species were identified through herbarium record and flora published by various botanists (Hooker JD, 1888-1890, Hooker JD 1849, Pradhan & Lachungpa, 1990, Kholia, 2010). The unidentified plant species in the field were photographed, and later identified by consulting plant taxonomists), Botanical Survey of India (BSI) and web references ([www.efloras.org](http://www.efloras.org); [www.flowersofindia.net](http://www.flowersofindia.net) & [www.floraofchina.org](http://www.floraofchina.org)). Help of local people/villagers were also taken to identify the local names of species in the field. All the sampling plots were geo-tagged for reference under long-term monitoring.

### **FAUNA**

Presence and relative abundance of most of the small and large fauna species was evaluated using methods that rely on indirect evidence such as animal burrows/holes, dung, pellets, scats, feeding signs, tracks, nests, digging and antler thrashing.

## Executive Summary

Rapid Biodiversity survey under the JICA assisted Sikkim Biodiversity Conservation and Forest Management Project (SBFP) is being carried out throughout the state since its inception in 2010. It is being conducted with the aim of developing baseline information of the forest areas in Sikkim, Monitoring and Evaluation of its impacts on forests ecosystem, carried out with the aim of its protection and conservation, to monitor any changes in vegetation composition over a period. This Rapid Biodiversity Survey on Monitoring of Biodiversity (Revisit Study) was conducted in the year 2018-2019 after a gap of 3years to 6 years prior to previous study in Protected Areas and some parts of Reserve Forests of Sikkim viz. Yuksom -Dzongri Sampling Path, KNP/KBR, West Sikkim, Singbha Rhododendron Sanctuary to Shiv Mandir Sampling Path, North Sikkim, Kyognosla Alpine Sanctuary, East Sikkim, Ravangla-Bhaleydunga Sampling Path, Maenam Wildlife Sanctuary , South Sikkim, Yakchey to Singbha Rhododendron Sanctuary Sampling Path, North Sikkim, Tendong Reserve Forest Sampling Path, South Sikkim, Sang- Tinjurey Sampling Path, Fambonglo Wildlife Sanctuary, East Sikkim, Kitam Bird Sanctuary, South Sikkim, Thangu – Lhasar Valley, North Sikkim.

Forest areas found to be healthy and rich in species diversity. Few species that was not recorded during first survey was also added, identifications of some species were also confirmed after the revisit study. During the revisit study, it was also brought to our knowledge that the locals in fringe areas are less dependent on our forest services such as for fodder, timber etc. Activities like poaching and grazing is also absent in the area.

# MONITORING OF BIODIVERSITY IN YUKSAM- DZONGRI- THANGSING - SAMITI LAKE SAMPLING PATHS ALONG THE TREKKING ROUTE OF KNP/KBR WEST SIKKIM, INDIA

*Sanjyoti Subba, Dorjee Chewang Bhutia and Sanchi Subba*



**Fig 1:** Wet Temperate Forest

## INTRODUCTION

Yuksam-Dzongri trekking route starts from Yuksam village, which is a historical/heritage village and now an important tourist destination of West Sikkim. Yuksam-Dzongri-Thangsing-Samiti lake sampling path is located in the Khangchendzonga National Park/Khangchendzonga Biosphere Reserve of West Sikkim. Based on topography and elevation, the habitat of KNP/KBR can be broadly categorized into wet temperate broad-leaved forests, temperate conifer forest, sub-alpine forest, alpine scrubs and alpine meadows. These extreme topographic

variations of the landscape provide diversity in the microclimatic conditions and habitat types, enriching the landscape as a biodiversity repository in the Himalayas. The park gets its name from Mt. Khangchendzonga, which is 8,586 m asl, the third-highest peak in the world. The park has rich diversity of floral, faunal and avi-faunal species. Additionally, this trekking route is home to many rare faunal species like Red panda, Snow leopard, Himalayan blue sheep, Himalayan goral, Himalayan thar, serow; and avifauna such as Blood pheasant, Himalayan monal, Kalij pheasant, Yellow billed-blue magpie and numerous others important species too. Therefore, the presentsurvey was carried out with the objective of rapid biodiversity survey to monitoring of biodiversity (revisit) along the trekking route to determine the availability and some changes of biodiversity over 5years of gap. Monitoring of biodiversity serves many goals, monitoring the forest ecosystem in their conservation areas gives response on the success of conservation measures.

## **RAPID BIODIVERSITY SURVEY**

A rapid biodiversity survey was conducted along the altitudinal range from 1800m to 4200m above sea level lying between latitude 27°23'30.0" N-27°30'28.1" N and longitude 88°09'37.1" E-88°10'59.4" E. Previous RBS survey was conducted in 2013 and after 5 years of gap the monitoring of biodiversity (revisit) was conducted on 2018, covering 45 sampling plots in Khangchendzonga Biosphere Reserve from Buffer zone to core zone (**Map**). The slope angle of the surveyed area is a maximum of 90° facing NW, NE, SE and Before we are proceeding to field work, survey team interaction with JFM/EDC president/member or (Community Organizer) for basic knowledge about the site.





Fig 2: Rapid biodiversity survey site along Yuksom-Dzongri trekking route, West Sikkim

## FIELD ACTIVITIES



**A**



**B**



**C**



**D**



**E**



**F**



**G**



**H**

**Fig 3:** Field activities of all along the

sampling plots (A to H photograph)



## FOREST TYPES



**Fig 4:** Wet temperate forest



**Fig 5:** Temperate coniferous forest



**Fig 6:** Rhododendron scrub



**Fig 7:** Sub - alpine forest



**Fig 8:** Valley covered with *Ranunculus pulchellus*

## **RESULT AND DISCUSSIONS (FLORAL DIVERSITY)**

A total of 198 plant species were documented in 1.8ha, which is more as compared to 129 plant species. A total of 45 sampling plots were laid of which 1-8 sampling plots were laid along Yuksam-Sachien, 9-12 sampling plots at Sachien-Bakhim, 13-18 sampling plots were laid in Bakhim-Tshoka in the wet temperate mixed forest. Other remaining sampling plots were laid in temperate coniferous forest to sub-alpine forest. The first survey is a inventory of biodiversity. Inventories provide baseline data about the presence or absence of species in an area, basic information which is essential for them to begin to understand community structure, function and processes. Monitoring (revisit) is a step beyond inventorying and refers to assessing how, and to what extent, biodiversity changes over time. Monitoring is essential for the continued management of biodiversity.

### **WET TEMPERATE FOREST**

In the wet temperate forest, the uppermost strata trees that provide the topmost canopy to the forest along the trekking route are *Acer campbellii*, *Castanopsis tribuloides*, *Prunus* sp., *Alnus nepalensis*, *Betula* sp., *Juglans regia*, *Rhododendron arboreum*, *Toona sureni*, *Macaranga denticulata*, *Choerospondias axillaris*, *Juglans regia*, *Tetradium fraxinifolium*, *Cinnamomum impressinervium*, *Elaeocarpus lanceaefolius*, *Engelhardtia spicata*, *Garuga floribunda*, *Quercus lamellosa*, *Magnolia doltsopa*, *Rhododendron arboreum*, *Acer campbellii*

and *Machilus edulis*. *Alnus nepalensis* was found growing in landslide affected areas and mainly along the water course. *Symplocos lucida*, *Symplocos glomerata* and *Ficus neriifolia* are found as the middle canopy cover. *Actinodaphne sikkimensis*, *Viburnum erubescence*, *Dichrofabrifuga*, *Edgeworthia gardenerii*, *Maesa rugosa*, *Rubus ellipticus*, *Zanthoxylum alatum* and *Engelhardtia spicata* are the common shrub species. Herbaceous as well as medicinal plant species *Polygonum molle*, *Anaphalis* sp., *Arisaema* sp., *Bidens pilosa*, *Pilea umbrosa*, *Drymaria cordata*, *Oxalis corniculata*, *Hedychium spicatum*, *Persicaria capitata*, *Swertia bimaculata*, *Centella asiatica*, *Viola* sp., *Hydrocotyle javanica*, *Artemesia vulgaris*, *Commelina benghalensis*, *Cyanodondactylon*, *Elatostema* sp., *Eupatorium adenophorum*, *Gnaphalium* sp., *Juncus* sp., *Persicaria* sp., *Pilea* sp., *Pouzolzia* sp., and *Spirea bella*, etc., were observed. The forest floor is extremely thick and was covered with numerous species of forbs, herbs, orchids, ferns and fern-allies, mushroom/mosses and lichens, etc. *Magnolia campbellii* which was found in Bakhim to Tshoka along the trekking route. *Mahonia sikkimensis* and *Viburnum erubescence* are commonly distributed. *Cardiocrinum giganteum* commonly called giant lily was encountered at Bakhim under the canopy of *Oak* species.

#### **Some biodiversity changes have been observed as follows**

1. Circumference breast height was found slightly higher as compared to previous study and the density of seedlings was also recorded higher in site.
2. Shrub species were adapted in the new environment are *Antidesma acuminatum* and *Brassaiopsis hispidawered* documented during monitoring of biodiversity along the Yuksam to Sachien.
3. *Mahonia sikkimensis* was categorized as endemic to Sikkim were found growing in Oak forest. *Aeschynanthus sikkimensis*, *Arisaema costatum* var. *sikkimense*, *Platanthera sikkimensis*, *Primula sikkimensis* and *Salix sikkimensis* were documented and also very important species in the region.
4. *Pleione hookeriana* which is one of the highest growing epiphytic orchid species found growing in full blooming stage in a lithophytes' and epiphytic in nature along Bakhim to Tshoka sampling path.
5. On the way to Bakhim -Tshoka, the rare orchid species '*Platanthera sikkimensis*' which is categorized as "Rare" orchid species in this region, found growing on Oak dead tree in the forest floor.
6. A parasitic plant, *Boschniakia himalaica* (Broomrape family), was encountered in the *rhododendron* forest near to Char mane Dara along the sampling path. No such anthropogenic disturbance was seen in the forest floor.





**Fig:** *Pleione hookeriana* (Lithophyte habitat)



**Fig:** *Pleione hookeriana* (epiphyte habitat) along the trekking route of Bakhim-Tshoka





**Fig:** *Platanthera sikkimensis* (J. D. Hooker) Kraenzlin, Orchid. Gen. Sp. 1: 621. 1898.

The sampling plots 19-32 were laid along *Tshoka-Phedang-Deorali Dara-Dzongri* trekking route. The elevation ranges between 3146m-3998m above sea level, covering the temperate coniferous forest to sub-alpine forest. The prominent *Rhododendron* species such as *Rhododendron falconeri*, *R. barbatum*, *R. camelliflorum*, *R. cinnabarinum*, *R. hodgsonii*, *R. thomsonii*, *R. decipiens*, *R. lanatum*, *R. campylocarpum*, *R. anthopogon*, *R. lepidotum*, *R. campanulatum*, *R. setosum* and *R. fulgens*, etc., were encountered. *Rhododendron* is an important genus occurring in the high altitudes, having ecological significance and economic importance in addition to its graceful flowers. Monitoring of biodiversity is key factor in the rhododendron forest because *Rhododendron* species are capability to hybrid in natural habitat which gives new species.

#### **TEMPERATE CONIFEROUS FOREST**

Major tree species in **temperate coniferous forest** are *Tsuga dumosa*, *Acer caudatum*, *Betula utilis*, *Prunus* sp., *Eurya acuminata*, *Sorbus macrophylla* were common along the trekking route. Shrub species such as *Rosa sericea*, *Daphne cannabina*, *Viburnum cordifolium*, *Berberis insignis*, *Ribes* sp. and *Ilex* sp. were encountered. The climber /epiphytic species such as *Agapetes serpens*, *Vaccinium* sp., *Smilax* sp., and *Holboellia latifolia*. *Arundinaria maling* (Malingo), was

encountered in sampling plot 22 at an elevation of 3290m above sea level. *Sphagnum squarrosum* (lichen species) was also found as lithophytes' in nature. The forest floor was mostly covered by ferns *Dryopteris redactopinnata* (Thunberg) and herb species such as *Primula*, *Potentilla*, *Arisaema*, *Carex*, *Poa*, *Geranium*, *Anaphalis*, *Juncus*, *Stephanandra*, *Hypericum*, *Bistorta*, *Polygonatum* species. Other predominant species such as *Swertia bimaculata*, *S. chirata*, *Heracleum wallichii*, *Clintonia udensis*, *Bergenia purpurascens* and *Cassiope fastigiata* were documented.

### SUB-ALPINE FOREST

On the way to *Deorali Dara*, dense patches of *Gaultheria trichophylla* were observed. As elevation increased, the vegetation was replaced by dwarf bush scrubs and large shrubs of *Rhododendron* species such as *R. setosum*, *R. anthopogon*, *R. lepidotum*, *R. ciliatum*, *Rhododendron cinnabarinum* and *R. hodgsonii* were recorded. Other *Rhododendron* species such as *R. vaccinioides* and *R. camelliflorum* were found to be epiphytic in nature. *Cassiope fastigiata* and a spreading shrub-let of *Gaultheria trichophylla* were abundantly covered the ground surface along the sampling path. *Clematis montana* was seen climbing on rhododendron species.



**Fig:** *Primula* and *rhododendron* species are mostly dominated in sub-alpine forest

Generally, species richness declines with increasing elevation. It is suggested that the distribution of species richness is likely to be governed by two or more environmental factors and not by single factor. At higher elevation, the rate of N mineralization and nitrification decreases resulting in slow rate of plant growth, competitive and normality as a consequence of



cooler temperate. So, the species richness was decrease in higher elevation. The sampling plots 33-37 were laid in the sub-alpine forest across the tree line whose elevation ranged between 3974m to 4106m above sea level.



**Fig:** *Rhododendron setosum* (Pink-purple) and *Rhododendron lanatum* (whitish)



**Fig:** Overview of Dzongri guest house and its surrounding areas of vegetation

*Dzongri* is a beautiful place covered by beautiful mountainous landscape, where the random sampling plots (38-42) were laid along *Dzongri-Char Mane-Kokchurung* covering sub-alpine

forest. The valley is covered by *Rhododendron-Primula* species. Dzongri and its surrounding areas were mostly dominated by *Rhododendron anthopogon*, *R. setosum*, *R. lepidotum*, *Juniperus* sp., and *Cassiope fastigiata* species. Amongst them, *Rhododendron anthopogon* was the most dominant taxa with two forms of *R. anthopogon* (pink or yellowish white) and *R. anthopogon* subsp. *hyphenanthum* (pale yellow to yellow-green). Other species such as *Carex*, *Primula*, *Juncus*, *Lagotis*, *Meconopsis*, *Rhodiola*, *Anemone*, *Cortia* species can be seen. The predominant species such as *Potentilla peduncularis* and *Arisaema jacquemontii*.

Along the **Char Mane area**, the herb species such as *Arisaema griffithii*, *A. jacquemontii*, *Caltha palustris*, *Cynoglossum* sp., *Didymocarpus* sp., *Potentilla peduncularis*, *Potentilla* sp., *Potentilla microphylla*, *Cortia* sp., *Eriocapitella* sp., *Gerenium* sp., *Primula sikkimensis*, *P. glabra*, *P. calderiana*, *P. denticulata*, *Meconopsis* sp., *Pedicularis siphonantha*, *Roscoea alpina*, *Cardamine macrophylla*, *Anaphalis nepalensis* var. *nepalensis*, *Cassiope fastigiata*, *Rhodiola* sp., *R. himalayense*, *Anemone* sp., *Juncus* sp., *J. thomsonii*, *Megacodon styophorus*, *Oxyria digna*, *Rheum acuminatum*, *Bistorta* sp., *Lagotis* sp., *Saxifraga* sp., *Voila biflora*, *Corydalis* sp., *Picrorhiza kurrooa*, *Scutellaria* sp., *Sibbaldia* sp., *Lloydia* sp., and *Ranunculus pulchellus*, etc., were recorded. The purple *Bergenia* (*Bergenia purpurascens*) was encountered at 3959m asl associated with *Rhododendron anthopogon*. Additionally, *Usnea sikkimensis* was seen favour on *Rhododendron cinnabarinum*. The presence of *Usnea sikkimensis* is a good indicator of the presence and richness of faunal species especially Musk deer.

**Thangsing-Kokchorung-Phedang** is another route to reach Dzongri. Three random sampling plots (43-45) were laid in the temperate coniferous forest. *Rhododendron hodgsonii*, *Sorbus* sp., and *Prunus* sp., were the predominant tree species forming the middle canopy cover.



**Fig:** Overview of Thangsing Log house

*Thansing* is a beautiful valley with huge steep mountains on either side of the log house over the Rathong Chu in West Sikkim and magnificent view of Mt. Pandim, Mt. Jopono and Mt. Tenchenkhang. The ground surface was fully covered with blooming of *Rununculus* species and *Rhododendron* species such as *R. anthopogon*, *R. setosum*, *R. lanatum* and *R. lepidotum*. *R. setosum* and *R. lepidotum* (crimson and purple form) were widely distributed from Deorali to Thansing. *Lonicera* sp., *Salix* sp., *Rhododendron lepidotum* (pink and crimson form), *Rununculus* sp., *Meconopsis simplifolia*, *Cardamine* sp., *Juncus thomsonii*, *Cyperus* sp., *Poa* sp., *Oxyria digna*, *Rhuem* sp., and *Cassiope fastigiata* were commonly seen along the route.

## **FAUNAL DIVERSITY**

The faunal species such as Red panda, Himalayan black bear, barking deer, Yellow-throated marten, Common leopard, Himalayan palm civet, Wild dog, Himalayan blue sheep, Marbled cat, Musk deer, Red fox, Weasel, Red panda, Wild pig, Leopard cat, Wild dog and Golden cat were recorded by photo captured and indirect evidences.



## **AVIANS AND BUTTERFLY SPECIES**

Apart from flora, the forests also harbor many faunal, avi-faunal and butterfly species too. Some of the butterfly was recorded directly through photo captured. Birds such as Blue-throated barbet, Blue whistling thrush, Blue-fronted redstart, Common green magpie, Snow pigeon, Common tailorbird, Crimson sunbird were encountered. Common green magpie is mostly sighted at Tshoka valley along the trek. *Satyr tragopan* was encountered at an elevation of 3323m asl in temperate coniferous rhododendron forest.

## **BIODIVERSITY CONSERVATION, RECOMMENDATION AND CONCLUSION**

For the conservation point of view, biodiversity information was collected during an inventory period which provided a baseline data, and after 4 years of gap for a monitoring study (revisit) was conducted. Yuksam-Dzongri trekking route sampling path showed some biodiversity changes as a significant rise in the plant population especially herb, that means no such anthropogenic disturbance occurred in the forest community development. A total of 198 plant species were documented in 1.8ha, which is more as compared to 129 plant species, 6 plant species such as *Aeschynanthus sikkimensis*, *Arisaema costatum* var. *sikkimense*, *Platanthera sikkimensis*, *Primula sikkimensis* and *Salix sikkimensis* were documented. *Mahonia sikkimensis* was categorized as endemic to Sikkim was found growing in Oak forest near to Bakhim along the sampling plots.

Yuksam-Dzongri trekking route is one of the best tourist destinations in west Sikkim. Khangchendzonga conservation Committee (KCC) of Yuksam, play a significant role by implementing of zero waste management plan by the involvement of local people, tourism support staff, along with JFMC/EDC Yuksam and forest field staff of Khangchendzonga National Park (KNP) are actively engaged for the foresaid. Biodiversity conservation through the practice of protecting and preserving is the wealth and genetic diversity which play an integral role for supporting many sectors of development like tourism, forest department, hydrology, soil and environment. It is suggested as recommended; monitoring is essential for identifying key issues for policy and forest management plan or policy-makers and general public for the state of biodiversity.



# Monitoring of biodiversity at Shingba Rhododendron Sanctuary to Shiv Mandir sampling path in North Sikkim, India

*Sanjyoti Subba & Sanchi Subba*



**Fig 1:** Sub-alpine forest of Shingba Rhododendron Sanctuary, North Sikkim

## INTRODUCTION

Shingba Rhododendron sanctuary is located at Lachung in North Sikkim. The sanctuary of forest types is characterized by Temperate Silver Fir-Rhododendron sub alpine forest at the head of the narrow Lachung valley surrounded by immense snowy mountains. The altitudinal ranges between 3200m to 4000m above sea level. The forest harbors a variety of rhododendron and medicinal plant species. The rhododendrons do exhibits high diversity in the sanctuary. Out of 39 rhododendron species found in Sikkim, over 30 species were found growing only in the sanctuary.



The present survey was carried out with the objective of rapid biodiversity survey to monitoring of biodiversity (revisit) along the trekking route to determine the availability and some changes of biodiversity over 4 years of gap. Monitoring of biodiversity is to check the recruitment, mortality, reproduction state and life stage to help forest and wildlife management plan.

## **RAPID BIODIVERSITY SURVEY**

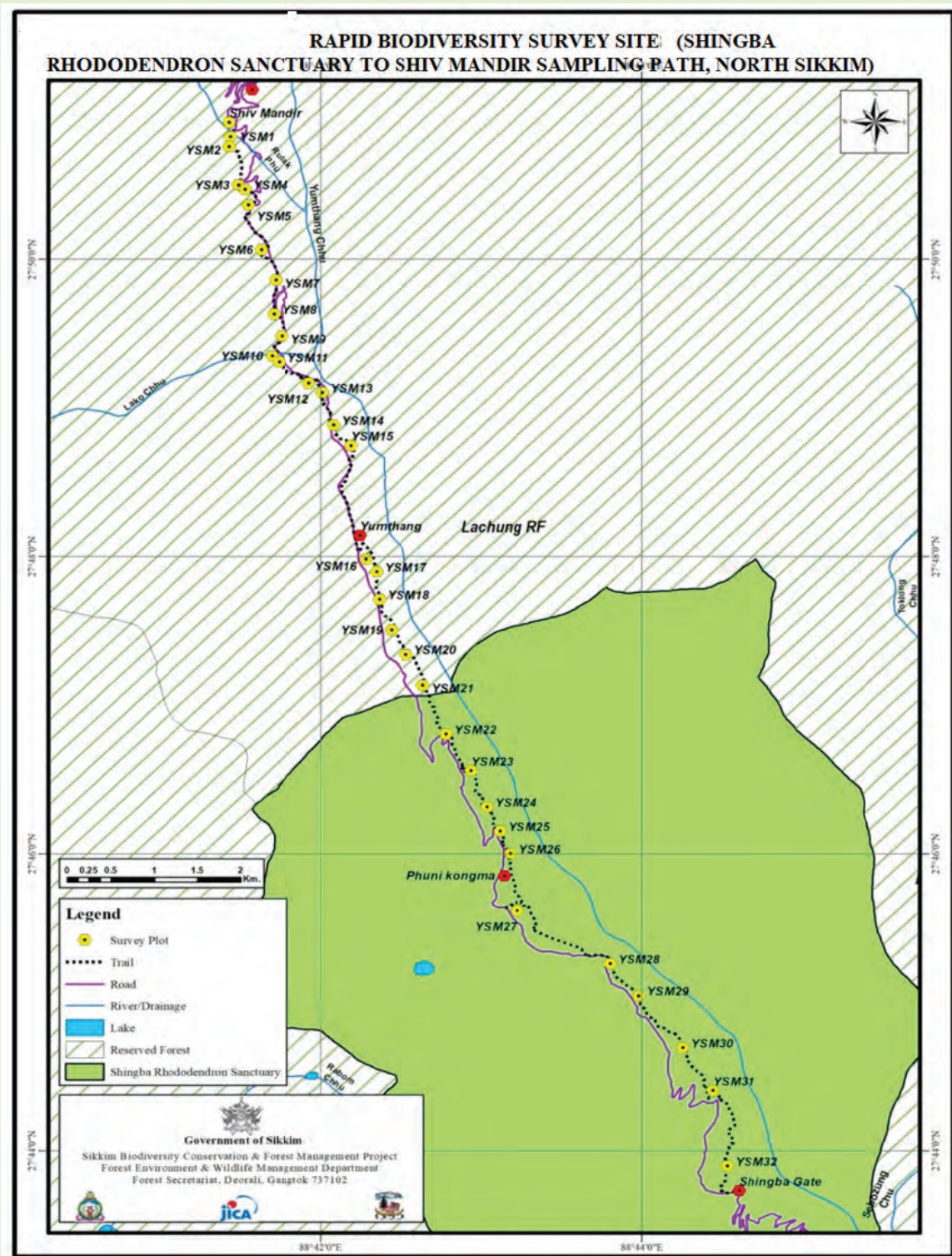
Monitoring of biodiversity survey was conducted in Shingba Rhododendron Sanctuary to Shiv mandir sampling path, North Sikkim. The study area of altitudinal gradients ranges from 3200m to 4000m above sea level provides sub alpine forest types. The study area lies between 27°50'49.3'' N -27°43'53.7'' N latitude and 88°41'26.2''E- 88°44'15.1''E. A total of 32 plots were laid covering 0.32 ha. The sanctuary is very rich in floral and faunal components. Previous survey was conducted on April-May 2014 in span of 5 year' time, the present study is to monitor the biodiversity i.e., revisit survey was conducted during April-May 2019.

## **FOREST TYPE**



**Fig:** Sub alpine forest





**Fig 2:** Rapid biodiversity survey site of Shingba Rhododendron Sanctuary to Shiv Mandir sampling path, in North Sikkim



## FIELD ACTIVITIES



A



B



C



D



E



F

**Fig 3:** Field activities at Shingba Rhododendron Sanctuary in North Sikkim



## FINDINGS AND DISCUSSION

A general checklist of floral species, 174 species recorded during the survey, herbs represented the highest number of 104 species (herb, mosses, orchid, climber and ferns) represented the highest number of species. Ericaceae was the dominant family in the sanctuary was recorded in all along the sampling plots.



**Fig 4:** Topmost strata in shiv mandir areas is *Abies densa*

The sampling plots 1 and 2 were laid from the Shiv mandir and its surrounding area. In all, 32 plots, *Abies densa* had the highest number of adults, saplings, and seedlings followed by intermediate canopy species such as *Salix sikkimensis* and *Betula utilis* associated with *Lyonia ovalifolia*, *Rhododendron barbatum*, *R. niveum*, *R. decipiens*, *R. campanulatum*, *R. campylocarpum*, *R. hodgsonii*, *R. thomsonii* and *Viburnum nervosum*. *Juniperus recurva* and *Rhododendron lepidotum* were dense forms on the forest floor along the sampling path. *Abies densa* is one of the key stone species for the conservation of epiphytic species especially wild orchids, ferns and fern-allies, *Hoya*, *Vaccinium*, species etc. *Pleione hookeriana* was encountered on the trunk of *Abies densa* which is one of the highest growing orchid species found in Sikkim. At an elevation of 3800m above sea level, the sampling plots of 3-6 plots were identified and laid along the sampling path. Along this sampling path, *Salix sikkimese*, *Betula utilis*, *Ribes* sp., commonly sighted. The most dominant *rhododendron* species are *Rhododendron wightii*, *Rhododendron campanulatum* sub sp. *campanulatum* and *Rhododendron campylocarpum* and



the common *rhododendron* scrub species such as *Rhododendron lepidotum* associated with *Rosa sericea*, *Juniperus recurva* and *Ribes* species. The ground flora such as *Gaultheria trichophylla*, *Rumex nepalensis*, *Primula denticulata*, *Hemiphragma heterophyllum*, *Veronica serpyllifolia* and *Potentilla*, *Saxifragria*, *Digitalis*, *Poa*, *Juncus*, *Kobresia*, *Bistorta*, *Gentiana*, and *Anaphalis* species were recorded all along the 7 to 11 sampling plots at an elevation of 3700m above sea level. Along the Yumthang valley, at an elevation of 3600m asl, the sampling plots of 12 to 15 were laid along the sampling path. Yumthang Valley is popularly known as “Valley of Flower” and is home to the Shingba Rhododendron Sanctuary in North Sikkim which is one of the best tourist destinations of north Sikkim.

After the Yumthang valley the sampling plots of 16-21 were laid at an elevation of 3600m above sea level. *Rhododendron decipiens* was observed and recorded only in sampling plot 20 associated with *Rhododendron hodgsonii* and *Abies densa*. A few populations have been observed in the specific location of *R. decipiens* need to preserve through the in-situ conservation strategy. A few population of *R. decipiens* were recorded from past decades its neither spread nor loss the habitat along the sampling path. The ground surface was highly dominated by *Gaultheria trichophylla* followed by *Poa* sp., *Potentilla* sp., *Fragaria nubicola*, *Arisaema griffithii*, *Digitalis* sp., *Oxalis* sp., *Polygonum* sp., *Bistorta* sp., *Potentilla* sp., *Fragaria nubicola*, *Oxalis* sp., *Arisaema* species and *Euphorbia sikkimensis* etc., were recorded. *Rhododendron hodgsonii* was dominant taxa along the sampling plot 21. The sampling plots of 23 to 26 were laid at an elevation of 3400m above sea level. *Primula denticulata* of good habitat was seen in the open canopy area with a full blooming stage in all the sampling plots.

Very few habitat of *Rhododendron anthopogon* (pink form) was seen in the valley (outside) the sampling plot. Other *rhododendron* species such as *R. anthopogon*, *R. lepidotum*, *R. campanulatum*, *R. wightii* and *R. hodgsonii* were recorded. For sampling plots of 28 to 30 were laid at an elevation of 3300m asl. The *rhododendron* species such as *Rhododendron barbatum*, *R. thomsonii*, *R. cinnabarinum*, *R. hodgsonii* which was dominant in the forest. In sampling plot 30 of the four rhododendron species were recorded such as *R. barbatum* had the least availability, whereas *R. hodgsonii*, *R. cinnabarinum* and *R. thomsonii* (three forms) had the highest presence in the sanctuary. The common shrub species such as *Viburnum nervosum* was recorded. At an elevation of 3200m asl, the sampling plot 31 and 32 were observed and laid. The higher regeneration potential sapling as well as seedling of *Abies densa* was recorded. *Rhododendron* species such as *Rhododendron niveum*, *R. hodgsonii*, *R. glaucophyllum* and

*Rhododendron arboreum* associated with common shrub species *Viburnum nervosum* and *Enkianthus deflexus* were recorded. The ground surface was fully covered by *Arisaema griffithii* associated with *Juncus* sp., *Poa* sp., ferns, *Oberonia* sp., *Viola biflora* etc. *Rhododendron virgatum* was found growing in the Lachen valley in the rocky areas along the roadsides.

### **SOME CHANGES WERE OBSERVED IN THE FOREST AS FOLLOWS**

1. Some landform changes could be seen during the monitoring of biodiversity survey period; a debris occurred in the sanctuary at *Phunekoma* area in the year 2015.



**Fig 6:** *Prim*



2. *Oberonia* species was found growing in the rhododendron forest.
3. The large shrub *Lonicera* sp. was inventoried during the monitoring of biodiversity survey.
4. Good regeneration potential was recorded of the *rhododendron* species in the sanctuary as compared to previous survey.



5. In the landslide area, *Rhododendron* species and *Betula utilis* were observed in the subalpine forest. *Betula utilis*, help to bind the soil in its natural habitat.
6. Above the Yumthang valley, it was observed that the *Usnea himalayana* was mostly seen in the forest as compared to previous survey. The Himalayan musk deer is highly dependent on the *U. himalayana* and is also an indicator of the existence and abundance of fauna.



## RHODODENDRON SPECIES



**Fig 7:** *Rhododendron glucophyllu*, *R.arboreum*, *R.niveum*, *R.ciliatum*, *R. hodgsonii*, *R.sikkimense*, *R.pendulum*, and *R. decipiens*.



## FAUNAL DIVERSITY

During the trial sampling, existence of a total of 5 mammalian species was recorded through indirect evidences. Avi-faunal species were recorded through local guide and direct sighting from the survey area. It is also observed that the *Betula utilis* is prominent habited of many wild animals and birds, including musk deer, Himalayan black bear and pheasants like Himalayan monal. Besides, it provides fodder to high altitude wild herbivores.

Table 1: Faunal species were encountered		
COMMON NAME	SCIENTIFIC NAME	Evidence
Yellow Throated Marten	<i>Martes flavigula</i>	PC,DS
Pika	<i>Ochotona sp.</i>	PC,DS
Serow	<i>Capricornis thar</i>	DS
Red panda	<i>Alirus fulgens fulgens</i>	IE
Himalayan black bear	<i>Ursus thibetanus laniger</i>	

**Note: PC-Photo captured, DS-Direct sighting, IE-indirect evidences**



**Fig 8:** Pika was encountered in the sanctuary



1.	Ashy throated warbler	<i>Phylloscopus maculipennis</i>
2.	Black bulbul	<i>Hypsipetes leucocephalus</i>
3.	Black faced laughing thrush	<i>Garrulax affinis</i>
4.	Blue Fronted Redstart	<i>Phoenicurus frontalis</i>
5.	Blue Whistling Thrush	<i>Myophonus caeruleus</i>
6.	Darjeeling Woodpecker	<i>Dendrocopos darjellensis</i>
7.	Dark Breasted Rosefinch	<i>Carpodacus nipalensis</i>
8.	Eurasian Woodcock	<i>Scolopax rusticola</i>
9.	Fire Tailed Sunbird	<i>Aethopyga ignicauda</i>
10.	Green Backed Tit	<i>Parus monticolus</i>
11.	Grey Backed Shrike	<i>Lanius tephronotus</i>
12.	Large Billed Crow	<i>Corvus macrorhynchos</i>
13.	Minivet	<i>Pericrococtus sp.</i>
14.	Oriental Turtle Dove	<i>Streptopelia orientalis</i>
15.	Griffon vulture	<i>Gyps himalensis</i>

## **MAJOR THREATS**

During the survey, the area was found to be devastated by landslides at several locations, causing great damage to the vegetation in the area. Major threat in the sanctuary is avalanche and the flash flood caused due to heavy snowfall. Log bridges were not in proper condition along the route. Grazing of animals (yaks and horses) has been observed at several places inside and outside the sanctuary but they are under control and are not a threat to the biodiversity at the moment. An increasing population of stray dogs has emerged as a serious threat to wildlife, and the killing of many animals by stray dogs has recently been reported from the area. Stray dog problems need to be resolved foremost.



**Fig 11 & 12:** Major threats along the sampling path in Shingba Rhododendron Sanctuary



### CONSERVATION RECOMMENDATION AND CONCLUSION

The study site is very rich in floral diversity which gives general indication that it supports considerable number of faunal presence and richness. The area is highly impacted by the natural as well as anthropogenic disturbance which needs immediate attention by manger. Results of monitoring can also be of direct relevance to policy making, forest management plan and wildlife management plan.

**Table 3: Site characteristics of Shingba Rhododendron Sanctuary to Shiv Mandir sampling path, North Sikkim**

Sampling Plots	Forest Type	Elevation (m)	Lat (N)	Long (E)	Slope angle	Slope aspect	Humus depth (cm)	Canopy%
1	Sub alpine	3916	27 50 49.3	88 41 26.2	10	SE	1	0
2	Sub alpine	3905	27 50 45.3	88 41 25.7	1	SE	2	0
3	Sub alpine	3880	27 50 29.8	88 41 29.1	40	SE	5	0
4	Sub alpine	3872	27 50 28.1	88 41 31.6	15	SE	0	0
5	Sub alpine	3838	27 50 21.8	88 41 32.7	15	SE	4	0
6	Sub alpine	3820	27 50 03.7	88 41 37.7	60	E	7	0
7	Sub alpine	3779	27 49 51.5	88 41 43.1	60	E	5	0
8	Sub alpine	3753	27 49 37.8	88 41 42.3	60	E	17	0
9	Sub alpine	3709	27 49 28.9	88 41 45.4	40	SE	7	0
10	Sub alpine	3648	27 49 80.8	88 41 41.7	30	NE	8	5
11	Sub alpine	3701	27 49 18.4	88 41 44.3	60	NE	0	0
12	Sub alpine	3692	27 49 09.8	88 41 55.4	40	NE	3.6	30
13	Sub alpine	3680	27 49 06.1	88 42 00.5	20	NE	1.7	0

14	Sub alpine	3654	27 48 53.0	88 42 04.6	10	E	1.9	60
15	Sub alpine	3640	27 48 44.6	88 42 11.1	5	E	0	0
16	Sub alpine	3642	27 47 58.3	88 42 16.7	5	E	3.9	5
17	Sub alpine	3641	27 47 53.6	88 42 20.6	5	E	3.2	50
18	Sub alpine	3631	27 47 42.5	88 42 21.8	5	E	0	20
19	Sub alpine	3613	27 47 30.2	88 42 26.3	5	E	3.7	0
20	Sub alpine	3607	27 47 20.3	88 42 31.8	10	E	0.6	0
21	Sub alpine	3606	27 47 07.9	88 42 38.0	5	E	5.7	60
22	Sub alpine	3591	27 46 48.2	88 42 46.7	20	E	5	80
23	Sub alpine	3490	27 46 33.3	88 42 55.9	20	E	7	90
24	Sub alpine	3452	27 46 18.6	88 43 01.9	15	E	4	70
25	Sub alpine	3438	27 46 08.8	88 43 01.7	30	E	2.7	30
26	Sub alpine	3422	27 45 59.8	88 43 10.7	5	E	1	0
27	Sub alpine	3386	27 45 36.9	88 43 13.1	5	NE	2	0
28	Sub alpine	3395	27 45 15.4	88 43 47.8	10	E	1.7	10
29	Sub alpine	3360	27 45 02.4	88 43 58.6	5	E	1	0
30	Sub alpine	3312	27 44 41.4	88 44 15.1	5	E	2	0
31	Sub alpine	3205	27 43 53.7	88 44 31.7	10	E	0	0
32	Sub alpine	3202	27 43 47.7	88 44 30.6	5	E	0	0

# Monitoring of biodiversity at Kyongnosla Alpine Wildlife Sanctuary sampling path, East Sikkim

*Sanjyoti Subba and Sumitra Nepal*



**Fig 1:** *Overview of Kyongnosla Alpine Sanctuary, East Sikkim*

## INTRODUCTION

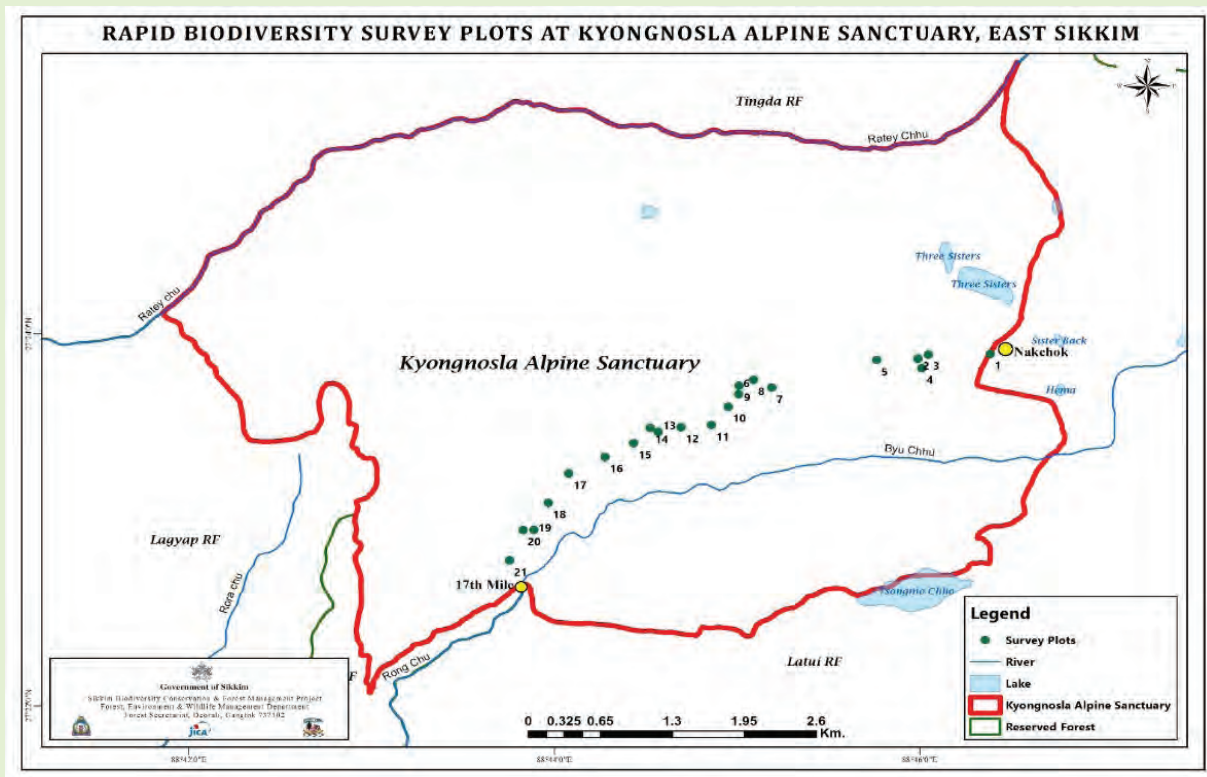
Kyongnosla Alpine Wildlife Sanctuary is located in the East District of Sikkim, established in 1977, occupying an area of 31sq.km sharing its border with east along the Rong-chu ridge up to Natso and in the west Kyongnosla police check post at J.N Road over the Rangchu in the eastern Sikkim. The altitudinal gradient of the sanctuary is 3000m to 4200m above sea level provides a wide range of topography leading to sub-alpine forest type. The sanctuary harbours over 100 medicinal plant species, especially *Aconitum* habitat, rhododendron, climbers, ferns and fern-allies, moss and lichens. Kyongnosla Alpine Wildlife Sanctuary is a biologically diverse sanctuary and well-known habitat for its high value medicinal plant species which was abundantly distributed in the sub alpine forest. The unique flora and fauna found here make this sanctuary is one of the biodiversity hotspots in this region. The effects of elevation, aspect and



slope play significant role in the sanctuary. The climate is wet and cool which is highly favorable for the growth of the medicinal plants. State Medicinal Plant Board (SMPB), Forest and Environment Department have demarcated Medicinal Plants Conservation Areas (MPCAs) in different locations within a state for the conservation of high value plant species through ex-situ conservation measures. Kyongnosla herbal nursery is one of them, which has a good habitat of high value medicinal plant species such as Kutki, Jatamanshi, Bikh, Panch pate, Pach Amla, Jinshing, Gurash, Salla, Padanghal, Banlasun and Bikhma were cultivated in 1 hectare at an elevation of 3304m above sea level. Besides flora, other wildlife species in this region are Red panda, Himalayan black bear, barking deer, Yellow-throated marten, Common leopard, Himalayan palm civet, Wild dog, Fox, Rufous-tailed Hare, Flying squirrel and Himalayan mouse hare. Birds such as Verditer Flycatcher, Plain mountain finch, spotted laughing thrush, Grey-backed shrike, Green-tailed sunbird, Green-backed tit and Blood pheasant.

## **STUDY AREA**

A rapid biodiversity survey was conducted along Nagchok to 17<sup>th</sup>Mile sampling path in Kyongnosla Alpine Sanctuary, East Sikkim. The study area of its elevation ranges between 3400m to 4100m above sea level. The work was commenced from Nagchok to cover the entire area, which is the entry point of the sanctuary. Nagchok is few kilometers distance from the road which has plenty of *rhododendron* habitat and many other medicinal plant species too. Previous survey was conducted on August 2016 in span of 3 year' time, the present study is to monitor the biodiversity i.e., revisit survey was conducted during August 2019. The slope angle of the area ranged between 5 to 50 degree and slope aspects towards E, N, NW and NE.



**Fig 2:** Rapid biodiversity survey site of Kyongnosla Alpine Sanctuary, East Sikkim



**Fig3:** Overview of Jhor Phokhari and vegetation from Nagchok at Kyongnosla Alpine sanctuary,



## EAST SIKKIM



Rhododendron scrub



Sub-alpine forest

**Table 1: Site Characteristics of Kyongnosla Alpine Sanctuary sampling path in East Sikkim**

Site code	Forest Type	Altitude (m) asl	GPS		Slope (o)	Slope Aspect	Disturbances
			Lat	Long			
<b>KAS 1</b>	Alpine Forest	4146	27°23'49.7"	88°46'25.1"	15	E	Nil
<b>KAS 2</b>	Alpine Forest	4097	27°23'48.5"	88°46'014"	30	E	Nil
<b>KAS 3</b>	Alpine Forest	4123	27°23'49.7"	88°46'04.8"	30	E	Nil
<b>KAS 4</b>	Alpine Forest	4069	27°23'45.4"	88°46'02.6"	20	E	Nil
<b>KAS 5</b>	Alpine Forest	4005	27°23'48.2"	88°45'47.8"	15	N	Nil
<b>KAS 6</b>	Sub-Alpine Forest	3970	27°23'37.8"	88°45'02.3"	10	NW	Nil
<b>KAS 7</b>	Sub-Alpine Forest	3920	27°23'39.7"	88°45'13.2"	10	NW	Nil
<b>KAS 8</b>	Sub-Alpine Forest	3891	27°23'42.4"	88°45'07.2"	30	N	Graze by Yak
<b>KAS 9</b>	Sub-Alpine Forest	3821	27°23'40.5"	88°45'02.5"	40	N	Graze by Yak
<b>KAS 10</b>	Sub-Alpine Forest	3757	27°23'33.8"	88°44'58.8"	30	NE	Graze by Yak
<b>KAS 11</b>	Sub-Alpine Forest	3792	27°23'27.9"	88°44'53.2"	40	NE	Nil
<b>KAS 12</b>	Sub-Alpine Forest	3781	27°23'02.4"	88°44'43.2"	30	E	Nil
<b>KAS 13</b>	Sub-Alpine Forest	3761	27°23'25.9"	88°44'35.7"	35	E	Nil
<b>KAS 14</b>	Sub-Alpine Forest	3713	27°23'27.3"	88°44'33.1"	20	E	Nil
<b>KAS 15</b>	Sub-Alpine Forest	3718	27°23'22.4"	88°44'27.6"	45	N	Nil
<b>KAS 16</b>	Sub-Alpine Forest	3669	27°23'18.1"	88°44'18.1"	30	NW	Nil
<b>KAS 17</b>	Sub-Alpine Forest	3607	27°23'12.9"	88°44'06.1"	5	E	Nil
<b>KAS 18</b>	Sub-Alpine Forest	3601	27°23'03.5"	88°43'59.2"	30	E	Nil
<b>KAS 19</b>	Sub-Alpine Forest	3538	27°22'05.9"	88°43'54.3"	45	E	Nil
<b>KAS20</b>	Sub-Alpine Forest	3489	27°22'54.8"	88°43'50.8"	50	E	Nil
<b>KAS21</b>	Sub-Alpine Forest	3412	27°22'45.1"	88°43'46.2"	10	E	Nil

## FINDINGS AND DISCUSSION (Floral diversity)

Over 180 plant species were recorded by laying 21 sampling plots, covering an area 0.21 ha. Higher plant diversity was recorded for herb as followed by shrub and tree. The sanctuary is one of the biodiversity hotspot in the region because of diverse ground vegetation which are highly

dominated by medicinal plants which are rare, endangered, threatened species in the sub alpine forest floor. High species richness means greater diversity and which leads to a higher community stability in the forest.

The sanctuary is one of the diverse medicinal plant habitat due to many factors such as a unique landforms, topography, climate, soils, slope exposure, geology and other abiotic factors. The variability of alpine environments is predominantly dependent upon altitude, water availability and seasonality, which are specific to each alpine region. As a general, the south-facing slopes of the mountains receive more sun radiation than do the northern slopes. The stable population of some of the medicinal plants like *Saussurea*, *Aconitum*, *Gentiana*, *Rhododendron* and *Rheum* species was observed. Sometime, the alpine soil is characteristically poor in nutrients and significantly degraded easily by global climate change, grazing and human activities. It may cause a great loss of biodiversity.

*Rhododendron* species was upper most dominant taxa along 3400m to 4100m above sea level in sub-alpine forest and associated with many scrub and ground vegetation. Few tree species such as *Abies densa*, *Betula utilis* and *Acer caudatum* were documented. The sanctuary harbour with *Rhododendron* species such as *R. campanulatum*, *R. campanulatum* subsp. *aeruginosum*, *Rhododendron hodgsonii*, *R. thomsonii* and *R. lepidotum*. The sanctuary is rich in high valued medicinal plants species such as *Bergenia purpurescens*, *Bistorta amplexicauli*, *Rheum acuminatum*, *Nardostachys jatamansi*, *Saussurea nepalensis*, *Potentilla arbuscula*, *P. peduncularis*, *Pedicularis siphonantha*, *Juniperus recurva*, *J. coxii*, *Codonopsis clematidea*, *Clematis napaulensis*, *Arisaema jacquemontii*, *Acomastylise latavareolata*, *Iris clarkei*, *Ligularia fischeri*, *Juncus himalensis*, *Juncus thomsonii*, *Juncus alpinoarticulatus*, *Persicaria wallichii*, *Polygonum vacciniifolium*, *Senecio raphanifolium*, *Valeriana hardwickii*, etc., which are abundantly flourishing in the area. Several species of rare medicinal herbs such as *Aconitum ferox*, *A. dissectum*, *A. novoluridum*, *A. violaceum*, *A. palmatum*, *Lagotis crassifolia*, *Saussurea obvallata*, *Bergenia purpurascens*, *Valeriana jatamansi*, *V. hardwickii*, *Gentiana elwesii*, *Neopicrorhiza scrophularia*, *Codonopsis foetans*, *Polygonatum cirrhifolium*, *Polygonatum verticillatum*, *Panax bipinnatifidus* etc., were also recorded in all along the sampling plots. Gentians species such as *Gentiana elwesii*, *Gentiana algida*, *Gentiana prolata*, *Gentiana sikkimensis*, *Gentianastylis phora*, *Swertia hookeri*, *Veratrum baillonii* and *Halenia elliptica* were recorded. The commonly available herb species such as *Berberis angulosa*, *Berberis insignis*, *Cassiope fastigiata*, *Gaultheria trichophylla*, *Gaultheria nummularioides*, *Rhodiola cretinii*, *R. himalensis*, *Sedum roseum*, *Potentilla arbuscula*, *P. cuneata*, *Primula capitata*, *Primula sikkimensis*, *Primula primulina*, *Ponerorchis chusua*, *Polygonum vacciniifolium*,



*Sinopodophyllum hexandrum*, *Pleuro spermum hookeri*, *Parnassia nubicola*, *Pedicularis siphonantha*, *P. oederi*, *P. megalantha*, *Oxyria digyna*, *Nepeta floccosa*, *Myricaria rosea*, *Maharanga emodi*, *Lilium nanum*, *Impatiens radiata*, *Impatiens bicornuta*, *Impatiens racemosa*, *Impatiens urticifolia*, *Acomastylis elata*, *Geranium wallichianum*, *Fritillaria cirrhosa*, *Fragaria nubicola*, *Euphorbia wallichii*, *Erigeron multiradiatus*, *Dracocephalum heterophyllum*, *Cynoglossum zeylanicum*, *Clematis nepaulensis*, *Bistorta affinis*, *Arisaema jacquemontii*, *A. griffithii*, *Arisaema erubescens*, *Anaphalis contorta*, *A. triplinervis*, *Allium prattii*, *A. wallichii*, *Gaultheria nummularioides*, *G. trichophylla*, *C. selaginoides*, *Berberis insignis*, *Berberis angulosa* and *Juniperus recurva* were documented.

### **Some biodiversity changes have been observed as follows;**

1. *Rheum nobile* was found growing on the rocky slopes associated with *Gentiana elwesii* and *Sorozeris hookeriana*.
2. Comparatively to the previous study more population of *Saussurea obvallata* was recorded. The Brahma Kamal, the much-revered flower of the Himalayas, is an excellent example of plant life at the upper limit of a high mountain. A postal stamp was issued by the Indian Postal Department to commemorate this flower. A small perennial herb growing up to 60 cm high. The entire Brahma Kamal plant can be used to treat many human diseases because of its bitter nature; it is an excellent liver tonic and a great appetizer for medicinal values. The soup made from this plant helps alleviate hepatitis and increases the amount of blood in the body. Plant extract is useful for treating urinary tract disorders. It destroys recurrent urinary tract infections and can be used as an effective remedy for sexually transmitted diseases. Brahma Kamal is an effective remedy to treat fever. The rhizomes in particular are used as an antiseptic and for healing cuts and bruises. In the Tibetan system of medicine (known as 'Amchi' system), the plant is used in the treatment of paralysis of limbs and cerebral ischemia.
3. *Anaphalis* species such as *Anaphalis busua*, *Anaphalis contorta*, *Anaphalis royleana*, *Anaphalis triplinervis*, *Anaphalis triplinervis* var. *monocephala*, *Anaphalis xylorhiza* were found growing in the sub-alpine forest.
4. *Rhododendron lanatum* which is categorised as eastern himalayan endemic species in Sikkim was found growing in the subalpine forest.



**Fig 4:** *Saussurea obvallata* full bloom at Kyongnosla Alpine Sanctuary, East Sikkim



**Fig 5:** *Saussurea obvallata* habitat at Kyongnosla Alpine Sanctuary, East Sikkim





**Fig 6:** *Rheum nobile* habitat & inflorescence



**Fig 7:** Diversity of ground vegetation at Kyongnosla Alpine Sanctuary, East Sikkim

Similarly, it has been observed that the predominance plant species *Pedicularis* are ecologically considered as keystone species due to their significant role in facilitating biodiversity in the sanctuary. Sikkim Himalaya is regarded as a hot spot of *Pedicularis* diversity, having about 55 species comprising 70% of the Indian Himalayan Taxa (Tambe & Rawat, 2011). In fact, other flowering plants are likely to produce more fruits and set more seeds when growing in close proximity to *Pedicularis*. A good population of *Pedicularis* can be seen in Kyongnosla Alpine sanctuary. The flower paste is also useful for neck and shoulder stress. For massage therapists, giving this plant to particularly tight patients before working on them can be helpful. The



sanctuary also shelters several threatened taxa, *Aconitum novoluridum*, *Codonopsis affinis*, *Primula glabra*, *Gentiana elwesii*, *Gentiana algida*, *Gentiana prolata*, *Gentiana sikkimensis*, *Gentiana stylophora*, *Swertia hookeri*, *Veratrillabaillonii* and *Halenia elliptica* and species of *Saussurea*. *Rheum nobile* was found growing on the rocky slopes associated with *Gentiana elwesii*, and *Soro-seris hookeri*



**Fig 9:** *Boschniakia himalaica*



**Fig 10:** *Primula glabra*

## FAUNAL DIVERSITY

The fauna species such as Red panda, Himalayan black bear, Himalayan barking deer, Yellow-throated marten, Common leopard, Himalayan palm civet, Wild dog, Fox, Rufous-tailed Hare and Flying squirrel are to be present in the sanctuary. Kyongnosla alpine sanctuary is located in the Eastern Himalaya Endemic Bird Area (EBA-130), one of the rich diversity of birds' species. As per the local expert, the Snow pigeon *Columba leuconota* would be seen in the winter season and other species such as Fire-tailed sunbird *Aethopyga ignicauda*, Golden Eagle *Aquila chrysaetos* and Greater spotted eagle *Aquila clanga* are common in this area. The globally threatened species, the most prominent would be Wood snipe *Gallina gonemorica* and Satyr tragopan *Tragopan satyra* (Near Threatened) and Monal *Lophophorus impejanus* are residents in this area. Kyongnosla Alpine Sanctuary is one of the important International Bird Areas code IN-SK-05 in East Sikkim.

## CONSERVATION RECOMMENDATION AND CONCLUSION

Kyongnosla Alpine Sanctuary is rich biodiversity and a repository of medicinal plants genetic resources in the state. State Medicinal Plant Board (SMPB), Forest and Environment Department have demarcated Medicinal Plants Conservation Areas (MPCAs) in this location as a Kyongnosla herbal garden in the conservation of high value plant species through ex-situ conservation measures. This is a vital role for the conservation of high value plant species. Sanctuary harbors many rare, endangered and Near Threatened medicinal plant species which have high value in the local, national as well as international market. As per the Convention on Biological Diversity (CBD) states that the systematics approach of medicinal plant conservation plays a vital role in environmental management and development through traditional as well as scientific practises.

Generally, this area needs more field exploration and re-documentation in different flowering season for future references. It is also suggested as recommended that every five years of gap like monitoring of biodiversity i.e., field exploration is needed to check the variability of species. Many species have not been assessed (NA) as in IUCN Redlist threatened species sources. However, such NA species are available in the alpine region of Kyongnosla that are rarely found. Hence, a regional status of such species could be generated for prioritizing the species for conservation of high value plant species.

**Table 2: Checklist of floral species (tree, shrub, herb, climbers, fern and lichens)**

	Scientific name	Family
1	<i>Abies densa</i>	Pinaceae
2	<i>Acer caudatum</i>	Sapindaceae
3	<i>Acomastylis elata</i>	Rosaceae
4	<i>Aconitum dissectum</i>	Ranunculaceae
5	<i>Aconitum ferox</i>	Ranunculaceae
6	<i>Aconitum laciniatum</i>	Ranunculaceae
7	<i>Aconitum novoluridum</i>	Ranunculaceae
8	<i>Aconitum palmatum</i>	Ranunculaceae
9	<i>Aconitum violaceum</i>	Ranunculaceae
10	<i>Aconogonum campanulatum</i>	Polygonaceae
11	<i>Aletris pauciflora</i>	Liliaceae
12	<i>Allium prattii</i>	Amaryllidaceae
13	<i>Allium wallichii</i>	Amaryllidaceae
14	<i>Anaphalis busua</i>	Asteraceae
15	<i>Anaphalis contorta</i>	Asteraceae
16	<i>Anaphalis royleana</i>	Asteraceae
17	<i>Anaphalis triplinervis</i> (Sims) C.B. Clark	Asteraceae
18	<i>Anaphalis triplinervis</i> var. <i>monocephala</i>	Asteraceae
19	<i>Anaphalis xylorihza</i>	Asteraceae
21	<i>Arisaema erubescens</i> (Wall.) Schott	Araceae
22	<i>Arisaema griffithii</i>	Araceae
23	<i>Arisaema jackuemonitii</i>	Araceae
24	<i>Artemisia sp</i>	Asteraceae
25	<i>Astilbe rivularis</i>	Saxifragaceae
26	<i>Berberis angulosa</i>	Berberidaceae
27	<i>Berberis insignis</i>	Berberidaceae
28	<i>Bergenia ciliata</i>	Saxifragaceae
29	<i>Bergenia purpurascens</i>	Saxifragaceae
30	<i>Betula utilis</i>	Betulaceae

31	<i>Bistorta affinis</i>	Polygonaceae
32	<i>Bistorta amplexicaulii</i>	Polygonaceae
33	<i>Bistorta vivipara</i>	Polygonaceae
34	<i>Boschniakia himalaica</i>	Orobanchaceae
35	<i>Calceolaria tripartita</i>	Scrophulariaceae
36	<i>Cardamine macrophylla</i>	Brassicaceae
37	<i>Cassiope fastigiata</i>	Ericaceae
38	<i>Cerastium</i> sp.	Asteraceae
39	<i>Chrysosplenium carnosum</i>	Saxifragaceae
40	<i>Chrysosplenium carnosum</i>	Saxifragaceae
41	<i>Clematis gouriana</i> Roxb.ex DC	Ranunculaceae
42	<i>Clematis napaulensis</i> DC.	Ranunculaceae
43	<i>Clinopodium umbrosum</i>	Lamiaceae
44	<i>Codonopsis clematidea</i> (Schernk) CL.	Campanulaceae
45	<i>Codonopsis foetens</i> Hook. &Thoms.	Campanulaceae
46	<i>Corydalis cornuta</i>	Papaveraceae
47	<i>Corydalis elegans</i> Wallich ex Hooker	Papaveraceae
48	<i>Corydalis juncea</i>	Papaveraceae
49	<i>Cynanthus inflatus</i> Hook.f.&Thoms	Campanulaceae
50	<i>Cynanthus lobatus</i>	Campanulaceae
51	<i>Cynoglos sumzeylanicum</i> (Vahl)Thunb. Ex Lehn	Boraginaceae
52	<i>Cynotisvaga</i> (Loureiro) Schultes	Commelinaceae
53	<i>Chrysosplenium carnosum</i> Hook.f. & Thomson	Saxifragaceae
54	<i>Dracocephalum heterophyllum</i> Edgeworth ex Bentham	Lamiaceae
55	<i>Dubyaeahispida</i> Candolle	Asteraceae
56	<i>Epilobium wallichianum</i> Hausknecht	Onagraceae
57	<i>Erigeron multiradiatus</i> (Lindle.ex DC.) Benth,ex CL.	Asteraceae
58	<i>Euphorbia wallichii</i> Hook.f.	Euphorbiaceae
59	<i>Fragaria nubicola</i> Lindley ex Lacaita	Rosaceae
60	<i>Fritillaria cirrhosa</i> D.Don	Liliaceae
61	<i>Galinsoga parviflora</i> Cavanilles	Asteraceae
62	<i>Galium</i> sp	Rubiaceae
63	<i>Gaultheria nummularioides</i>	Ericaceae
64	<i>Gaultheria trichophylla</i>	Ericaceae
65	<i>Gentianaalgida</i> Pallas	Gentianaceae
66	<i>Gentiana elwesii</i> C.B.Clarke	Gentianaceae
67	<i>Gentiana prolata</i> I.B.Balfour	Gentianaceae
68	<i>Gentiana sikkimensis</i> C.B. Clarke	Gentianaceae



69	<i>Gentiana stylophora</i> C.B. Clarke	Gentianaceae
70	<i>Geranium polyanthes</i>	Geraniaceae
71	<i>Geranium wallichianum</i> Don ex. Sw.	Geraniaceae
72	<i>Gymnadenia orchidis</i> Lindl.	Orchidaceae
73	<i>Halenia elliptica</i> D. Don	Gentianaceae
74	<i>Himalaiella andersonii</i> C.B. Clarke	Asteraceae
75	<i>Impatiens bicornuta</i> Wall	Balsaminaceae
76	<i>Impatiens racemosa</i> Candolle	Balsaminaceae
77	<i>Impatiens radiata</i> Hook.	Balsaminaceae
78	<i>Impatiens urticifolia</i> Wallich	Balsaminaceae
79	<i>Iris clarkei</i> Baker ex Hook.f.	Iridaceae
80	<i>Juncus alpinoarticulatus</i> Chaix	Juncaceae
81	<i>Juncus himalensis</i> Klotzsch	Juncaceae
82	<i>Juncus inflexus</i> L.	Juncaceae
83	<i>Juncus membranaceus</i>	Juncaceae
84	<i>Juncus thomsonii</i> Buchenau	Juncaceae
85	<i>Juniperus recurva</i>	Cupressaceae
86	<i>Juniperus</i> sp.	Cupressaceae
87	<i>Jurinea dolomiaea</i> - Bioss Boiss	Asteraceae
88	<i>Kobersia</i> sp.	
89	<i>Lagotis crassa</i> folia Prain	Scrophulariaceae
90	<i>Leontopodium jacotianum</i>	Asteraceae
91	<i>Ligularia amplexicaulis</i> DC	Asteraceae
92	<i>Ligularia fischeri</i> (Ledebour) Turczaninow	Asteraceae
93	<i>Ligularia mortonii</i> (C.B. Clarke)	Asteraceae
94	<i>Lilium nanum</i> Klotzsch & Garcke	Liliaceae
95	<i>Lobelia</i> sp.	Campanulaceae
96	<i>Lonicera</i> sp.	Caprifoliaceae
97	<i>Lyonia ovalifolia</i>	Ericaceae
98	<i>Maharan gaemodi</i> (Wallich) A de Candolle	Boraginaceae
99	<i>Meconopsis horridula</i> Hook.f. & Thoms.	Papaveraceae
100	<i>Meconopsis spaniculata</i> (D. Don) Prain	Papaveraceae
101	<i>Meconopsis simplicifolia</i> (D. Don) Walpers	Papaveraceae
102	<i>Meconopsis villosa</i> (Hook.f.) G. Taylor	Papaveraceae
103	<i>Megacodon stylophorus</i> (C.B. Clarke)	Gentianaceae
104	<i>Myricaria rosea</i> W.W. Smith	Tamaricaceae
105	<i>Nardostachys jatamansi</i> (D. Don) Candolle	Valeriaceae
106	<i>Neopicrorhiza scrophulariiflora</i> (Pennall)	Scrophulariaceae

107	<i>Nepeta floccosa</i> Benth.	Lamiaceae
108	<i>Oxyria digyna</i> (L.)Hill	Polygonaceae
109	<i>Parnassia nubicola</i> Wall.exRoyle	Parnassiaceae
110	<i>Pedicularis longiflora</i> Rudolph	Scrophulariaceae
111	<i>Pedicularis megalantha</i> D.Don	Scrophulariaceae
112	<i>Pedicularis oederi</i> Vahl.	Scrophulariaceae
113	<i>Pedicularis siphonantha</i> D.Don	Scrophulariaceae
114	<i>Pedicularis trichoglosa</i> Hook.	Scrophulariaceae
115	<i>Pedicularis mollis</i>	Scrophulariaceae
116	<i>Persicaria uncinata</i>	Polygonaceae
117	<i>Persicaria wallchii</i> Greuter&Burdet	Polygonaceae
118	<i>Phlomis bracteosa</i>	Lamiaceae
119	<i>Phlomis tibetica</i>	Lamiaceae
120	<i>Plantago major</i>	Plantaginaceae
121	<i>Pleurospermum hookeri</i> C.B. Clarke	Apiaceae
122	<i>Pleurospermopsis sikkimensis</i>	Apiaceae
123	<i>Polygonatum cathcartii</i> Baker	Polygonaceae
124	<i>Polygonatum cirrhifolium</i> (Wallich)Royle	Polygonaceae
125	<i>Polygonatum singalilense</i> H.Hara	Asparagaceae
126	<i>Polygonatum verticellatum</i> (L.) All	Polygonaceae
127	<i>Polygonum vacciniifolium</i> Wall.ex Meisner	Polygonaceae
128	<i>Ponerorchis chusua</i> D.Don	Orchidaceae
129	<i>Potentilla arbuscula</i> D.Don	Rosaceae
130	<i>Potentilla cuneata</i> Wallich ex Lehm.	Rosaceae
131	<i>Potentilla peduncularis</i> D.Don	Rosaceae
132	<i>Primula capitata</i> Hook.	Primulaceae
133	<i>Primula glabra</i>	Primulaceae
134	<i>Primula primulina</i> (Spreng.) H .Hara	Primulaceae
135	<i>Primula reticulata</i> Wallich	Primulaceae
136	<i>Primula sikkimensis</i> Hook.f.	Primulaceae
137	<i>Prunella vulgaris</i>	Lamiaceae
138	<i>Rheum acuminatum</i> Hook.f.&Thoms.ex Hook.	Polygonaceae
139	<i>Rheum nobile</i> Hook. f. &Thoms	Polygonaceae
140	<i>Rhodiola cretinii</i> (Raymond-Hamet)	Crassulaceae
141	<i>Rhodiola himalensis</i> (D.Don) S.H. Fu	Crassulaceae
142	<i>Rhododendron anthopogon</i>	Ericaceae
143	<i>Rhododendron campanulatum</i>	Ericaceae
144	<i>Rhododendron campanulatum</i> subsp. <i>aeruginosum</i>	Ericaceae

145	<i>Rhododendron hodgsonii</i>	Ericaceae
146	<i>Rhododendron hypenanthum</i>	Ericaceae
147	<i>Rhododendron lanatum</i>	Ericaceae
148	<i>Rhododendron setosum</i>	Ericaceae
149	<i>Rhododendron thomsonii</i>	Ericaceae
150	<i>Rosa sericea</i>	Rosaceae
151	<i>Rumex nepalensis</i>	Polygonaceae
152	<i>Salix sikkimensis</i>	Salicaceae
153	<i>Satyriumnepalense</i> D.Don	Orchidaceae
154	<i>Saussurea gossipiphora</i> D.Don	Asteraceae
155	<i>Saussurea nepalensis</i> Sprengel	Asteraceae
156	<i>Saussurea obvallata</i> (DC).Edgew.	Asteraceae
157	<i>Saussurea simpsoniana</i> (Field & Gard.) Lipschitz	Asteraceae
158	<i>Saxifraga brachypoda</i> D.Don	Saxifragaceae
159	<i>Saxifraga engleriana</i> Harry Smith	Saxifragaceae
160	<i>Saxifraga stenophylla</i> Royle	Saxifragaceae
161	<i>Scutellaria discolor</i> Colebr.	Lamiaceae
162	<i>Sedum roseum</i> (L.)Scop.	Crassulaceae
163	<i>Selenium wallichinum</i> (DC.) Raizada&H.O.Saxena	Apiaceae
164	<i>Senecio graciliflorus</i> DC	Asteraceae
165	<i>Senecio raphanifolium</i> Wall.ex DC.	Asteraceae
166	<i>Senecio scandens</i> Buch.Ham.exD.Don	Asteraceae
167	<i>Shivparvatia glanduligera</i> (Edgew.) Pusalkar& D.K (3)	Caryophyllaceae
168	<i>Sibbaldia purpurea</i>	Rosaceae
169	<i>Silene nigrescens</i> L.	Caryophyllaceae
170	<i>Sinopodophyllum hexandrum</i> (Royle) T.S.Ying	Lardizabalaceae
171	<i>Soroseris hookeriana</i> (C.B. Clarke) Stebbins	Asteraceae
172	<i>Stellaria nepalensis</i>	Caryophyllaceae
173	<i>Swertia hookeri</i> C.B.Clarke	Gentianaceae
174	<i>Swertia speciosa</i>	Gentianaceae
175	<i>Taraxacum officinale</i> Weber	Asteraceae
176	<i>Taraxacum</i> sp	Asteraceae
177	<i>Thalictrum cultratum</i> Wallich	Ranunculaceae
178	<i>Thalictrum reniforme</i> Wall.	Ranunculaceae
179	<i>Valeriana hardwickii</i> Wall.	Valerianaceae
180	<i>Veratrilla bailonii</i> Franchet	Gentianaceae



Table 3: Checklist of Avi-fauna in Kyongnosla Alpine Wildlife Sanctuary			
Sl. No	Scientific Name	Common Name	Family
1.	<i>Phylloscopus maculipennis</i>	Ashy-throated warbler	Phylloscopidae
2.	<i>Trochalopteron affine</i>	Black-faced Laughingthrush	Leiothrichidae
3.	<i>Ithaginis cruentus</i>	Blood pheasant	Phasianidae
4.	<i>Myophonus caeruleus</i>	Blue whistling thrush	Muscicapidae
5.	<i>Corvus splendens</i>	Common crow	Corvidae
6.	<i>Acridotheres tristis</i>	Common myna	Sturnidae
7.	<i>Passer domesticus</i>	common Sparrow	Passeridae
8.	<i>Procarduelis nipalensis</i>	Dark-breasted Rosefinch	Fringillidae
9.	<i>Aethopyga ignicauda</i>	Fire-tailed Sunbird	Nectariniidae
10.	<i>Parus monticolus</i>	Green-backed tit	Paridae
11.	<i>Lophura leucomelanos</i>	Kalij Pheasant	Phasianidae
12.	<i>Streptopelia orientalis</i>	Oriental turtle dove	Columbidae
13.	<i>Pyrhacorax pyrrhocorax</i>	Red-billed chough	Corvidae
14.	<i>Pyrhula erythrocephala</i>	Red-headed bullfinch	Fringillidae
15.	<i>Tragopan satyra</i>	Satyr tragopan	Phasianidae
16.	<i>Columba leuconota</i>	Snow pigeon	Columbidae
17.	<i>Phoenicurus leucocephalus</i>	White-capped redstart	Muscicapidae
Table 4: Checklist of faunal species encountered at Kyongnosla alpine sanctuary, East Sikkim			
1.	<i>Cannis aurens</i>	Jackal	Canidae
2.	<i>Capricornis thar</i>	Himalayan serow	Bovidae
3.	<i>Hylopetes alboniger</i>	Particolored flying squirrel	Sciuridae
4.	<i>Martes flavigula</i>	Yellow-throated marten	Mustelidae
5.	<i>Muntiacus muntjak</i>	barking deer	Cervidae
6.	<i>Naemorhaedus goral</i>	Goral	Bovidae
7.	<i>Paguma larvata</i>	Himalayan palm civet	Viverridae
8.	<i>Sus scrofa</i>	Wild pig	Suidae
9.	<i>Ursus thibetanus</i>	Himalayan black bear	Ursidae
<p><b>NOTE:</b> <b>S:</b> Sighting, <b>Pc:</b> Photo capture, <b>Sc:</b> Scat, <b>P:</b> Pellet, <b>HM:</b> Hoof mark, <b>C:</b> Call, <b>F:</b> Feather, <b>D:</b> Droppings, <b>Sm:</b> scratch marks, <b>Ds:</b> Digging sign,</p>			

# Monitoring of Biodiversity in Ravangla-Bhaley Dhunga Sampling Path of Maenam Wildlife Sanctuary, South Sikkim

*Sanjyoti Subba & Dorjee Chewang Bhutia*



**Fig 1:** View from Maenam wildlife sanctuary

## **INTRODUCTION**

Maenam Wildlife Sanctuary was established in 1987 which is located in South district of Sikkim. It is located on the Maenam-Tendong ridge and is drained by the Teesta River in the east and the Rangeet River in the west direction. The sanctuary has a water stream which is sources of drinking water for the villages of Ravangla and also for Namchi bazaar, South Sikkim. Government of Sikkim has proposed and under constructing a ropeway 22 kilometers from the Maenam Wildlife sanctuary. The meaning of Maenam-la is “treasure –house of medicines” and the sanctuary is a rich diversity of medicinal plants. The Sanctuary is also rich floral and faunal diversity. Sanctuary is one of the most tourist destinations from Ravangla to reach Bhaley Dhunga during spring season. The name Bhaley means ‘cock’ and Dhunga means ‘rock’, and

may have gotten its name from the incessant breeding calls of male pheasants perched on his vantage point. It is believed that the people living in the adjoining villages come to worship Lord Shiva on the top of this rock to fulfill the dreams. Sanctuary is home to many fauna species such as Red panda, Himalayan black bear, Himalayan barking deer, Common leopard and Himalayan goral, etc., and many birds and butterflies too.

### **RAPID BIODIVERSITY SURVEY**

A rapid biodiversity survey was conducted along Ravangla-Bhaley Dhunga sampling path in Maenam Wildlife Sanctuary, South Sikkim. Previous RBS survey was conducted in Oct 2013 and after 5 years of gap the monitoring of biodiversity (revisit) was conducted on October, 2018, covering 25 sampling plots of Maenam Wildlife Sanctuary, South Sikkim. The study area of elevation ranges between 2100m to 3252m above sea level provides a wide range of topography leading to two types of forest such as wet temperate forest to temperate coniferous forest along the sampling path.

### **FOREST TYPES**

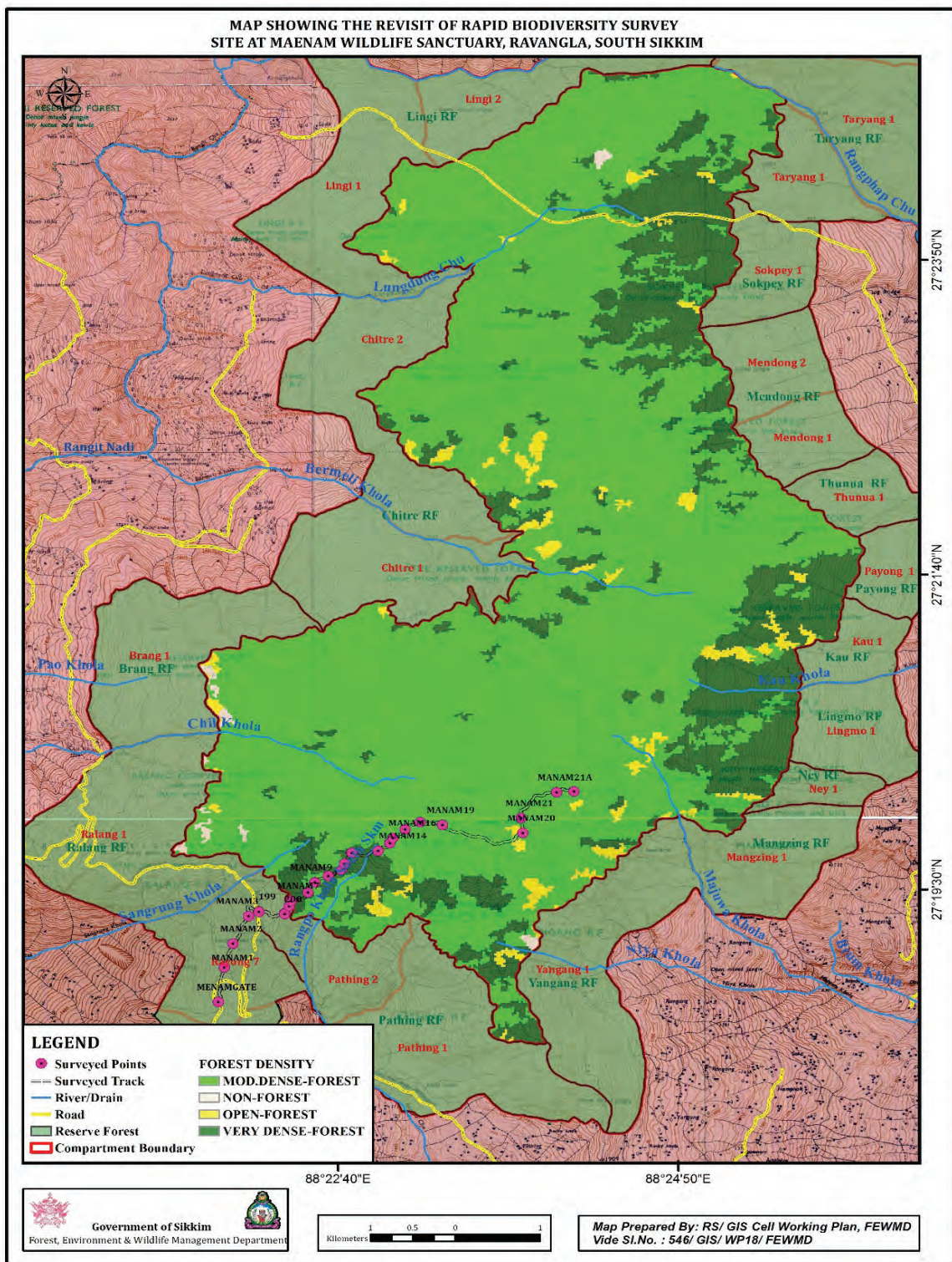


**Fig 2:**Wet temperate forest



**Fig 3:**Temperate coniferous forest





**Fig 5:** Rapid biodiversity survey site of Maenam Wildlife Sanctuary, South Sikkim

**Table 2: Site characteristics of Ravangla- Bhaley Dhunga sampling path**

Plot	Elevation (M) asl	Latitude				Longitude			Slope (°)	Aspect	Canopy Cover (%)	Broad Forest Type	
1	2187	27	18	96	3	88°	21	94	0	20	W	30	Temperate forest
2	2239	27	19	12	7	88°	21	99	6	15	SW	20	Temperate forest
3	2287	27	19	31	6	88°	22	9	5	10	SW	20	Temperate forest
4	2338	27	19	34	8	88°	22	16	0	20	WS	90	Temperate forest
5	2427	27	19	33	4	88°	22	12	5	55	SW	0	Temperate forest
6	2455	27	19	38	4	88°	22	35	3	45	SW	60	Temperate forest
7	2504	27	19	42	0	88°	22	36	5	10	SW	30	Temperate forest
8	2508	27	19	47	9	88°	22	47	3	20	SW	60	Temperate forest
9	2609	27	19	54	8	88°	22	51	7	5	SW	50	Temperate forest
10	2659	27	19	59	2	88°	22	60	2	10	SW	20	Temperate forest
11	2711	27	19	63	4	88°	22	68	6	15	SW	60	Temperate forest
12	2748	27	19	67	8	88°	22	70	5	40	SW	20	Temperate forest
13	2814	27	19	75	1	88°	22	75	3	10	SW	60	Temperate forest
14	2848	27	19	76	5	88°	22	92	0	20	SW	80	Temperate forest
15	2884	27	19	81	8	88°	22	99	4	5	NE	30	Temperate forest
16	2912	27	19	85	4	88°	23	1	4	10	NE	70	Temperate forest
17	2965	27	19	91	3	88°	23	9	3	45	NW	0	Temperate forest
18	3022	27	19	96	2	88°	23	18	9	15	NE	30	Temperate forest
19	3057	27	19	94	3	88°	23	33	0	5	WS	0	Temperate conifer Forest
20	3098	27	19	88	9	88°	23	84	3	25	W	0	Temperate conifer Forest
21	3153	27	19	99	1	88°	23	83	0	15	W	0	Temperate conifer Forest
22	3207	27	20	17	0	88°	24	5	7	0	SE	20	Temperate conifer Forest
23	3252	27	20	4	5	88°	23	28	6	0	NE	5	Temperate conifer Forest
24	3241	27	20	11	4	88°	24	8	2	10	W	10	Temperate conifer Forest
25	3155	27	20	1	8	88°	23	49	7	20	NE	5	Temperate conifer Forest



## FIELD ACTIVITIES



A



B



C



D



E



F

**Fig 6:** Field activities of Maenam Wildlife Sanctuary, South Sikkim



## **FINDINGS AND DISCUSSION (Floral diversity)**

A total of 145 plant species were more as compared to 113 plant species (previous survey) by laying random 25 sampling plots, covering an area 0.25 ha along the trekking route. The upper most strata trees that provide the topmost canopy to the forest in the sanctuary are *Prunus nepalensis*, *Castanopsis tribuloides*, *Daphniphyllum himalyense*, *Magnolia doltsopa*, *Alnus nepalensis* and *Acer campbellii* in temperate forest. Elevation increased the fruit bearing tree species such as *Machilus edulis*, *Juglans regia*, *Quercus lamellosa*, *Rhus wallichii*, *Erythrina arborescence*, *Acer campbellii*, *Acer caudatum* and *Acer palmatum* were recorded. The lower strata consist of *Symplocos lucida*, *Rhododendron grande*, *Eurya acuminata*, *Ilex* sp., *Brassaiopsis mitis* and *Symplocos glomerata* in the wet temperate forest. The temperate climate offers the optimum condition for luxuriant growth of epiphytes, orchid, ferns and fern-allies. Maximum number of epiphytic species was observed in the wet temperate forest as compared to previous survey. *Rhododendron arboreum* was seen growing along the sampling path which was planted.



**Fig 7:** Wet temperate forest with enormous epiphytic species

The characteristics of temperate forest of the sanctuary which comprise of heavy summer rainfall, presence of heavy fog and mist almost throughout the year and severe winter with occasional snowfall revealed the rich diversity of flora as well as fauna species. *Lithocarpus pachyphyllus* was observed significantly higher (CBH; 700cm) circumference breast height was

recorded along the sampling plot. The higher frequency of occurrence and density of seedling was recorded that means the monitoring of biodiversity is foremost to check the status of availability of biodiversity in the region.



**Fig 8:** Sapling of *Acer campbellii* in the wet temperate forest

Middle strata under the canopy of tree species are *Polygonum molle*, *Viburnum erebuscence*, *Osbeckia stellata*, *Rubus ellipticus* and *Rubus nevius* were found dense in the forest. The ground floor is covered by herbaceous plant species are *Arisaema* sp., *Laportea terminalis*, *Swertia bimaculata*, *Pilea umbrosa*, *Drymaria cordata*, *Oxalis corniculata*, *Hedychium spicatum*, *Persicaria capitata*, *Fragaria nubicola*, *Swertia bimaculata*, *Centella asiatica*, *Viola* sp., *Hydrocotyle javanica*, *Rumex nepalensis*, *Anaphalis* sp., *Bidens pilosa* and *Carex* sp., were recorded. Other climber species are *Rubia cordifolia*, *Smilax* sp., and *Herpetospermum pedunculatum* are common along the sampling path.

**Some biodiversity changes were recorded in the forest floor as follows;**

1. Two orchid species such as *Bulbophyllum* sp., and *Cymbidium* sp., were found growing in the temperate forest.
2. *Impatiens bicornuta* was found growing along the sampling plot 14. Like-wise the habitat of Pteridophytes, *Angiopteris indica* and *Monachosorum henryi* were recorded in sampling plot 7 & 8 in the sanctuary.
3. *Rhododendron grande* and *Lithocarpus pachyphyllus* were found planted along the sampling plots 1 & 4 along the trekking route. *Rhododendron grande* which is eastern Himalayan endemic species and *Rhododendron barbatum* which has regional status as



vulnerable were found growing in the forest. *Rhododendrons* are one of the main taxa in the temperate to sub-alpine forests of Sikkim Himalaya. *Rhododendron* provides a food source for a wide range of animals, with enormous flowers, providing a range of insects, birds and butterflies, which are frequent pollinators. *Rhododendrons* can be considered as the keystone element in the context of upper temperate and the alpine region of Sikkim Himalayas.

4. *Paris polyphylla* is one of the medicinal plants listed as vulnerable by the IUCN was found growing in the forest. *Satyrium nepalensis* and *Coelogyne cristata* were categorized as the threatened orchid species were recorded in the temperate coniferous forest. Orchids have such a physiological character which should be adapt in new environments or it remain dormant for long periods in the courage of a suitable environmental, if fail they become extinct.



**Fig 9:** *Impatiens bicornuta*

At an elevation ranges between 2814m to 2965m above sea level in temperate coniferous forest. It is a terrestrial habitat type and the climate is warm summer, cool winter and varies in their kind of plant life forms. The surveyed sampling plots 13 to 17 was laid, which was lying between latitude 27°19'75.1" to 27°19'91.3" and longitude 88°22' 75.3" to 88°23' 09.3". The top most strata *Abies densa* is the prominent tree species followed by *Rhododendron grande*, *Lithocarpus pachyphyllus*, *Machilus* sp., *Acer caudatum* and *Rhododendron falconeri*, and



*Daphniphyllum himalyense* etc. The middle strata such as *Viburnum rubescence*, *Rosa sericea*, *Rubus neivius*, *Smilax rigida* and *Ribes* sp., *Anaphalis* sp., are abundantly distributed along the sampling path. The fruit bearing species are *Gaultheria hookeri*, *Gaultheria trichophylla* and *Gaultheria nummulariodes* which were abundantly distributed in temperate coniferous forest. Maenam wildlife sanctuary is a rich biodiversity in the temperate forest, but in case of temperate coniferous forest is disturbed by constructing of Skywalk and disturbance by tourist flow. The major threat of biodiversity loss is the rapid increased by tourist flow along the trekking route.



**Fig 10:** Cultural significance; Local people worship the Lord Shiva on the top of this rock

## **FAUNAL DIVERSITY**

Sikkim harbor 125 mammal's species by (Chakraborty 2011) recently updated more than 144 mammal species (envisskm.nic.in), 9 mammals were encountered in the monitoring of biodiversity at Maenam Wildlife Sanctuary, South Sikkim. Apart from the mammals, state lies within the Eastern Himalayan Endemic Bird Area (Islam and Rahmani, 2004). Maenam Wildlife Sanctuary-Tendong Reserve Forest is one of the IBAs and IBA criteria IN-SK-08 in Sikkim. Birdlife International has listed 112 species in this biome (Lachungpa *et al.* 2011), of which 28 bird species were recorded during the present survey including Common hill partridge and *Tragopan satyra*. The globally threatened species of this site, *Tragopan satyra* is considered as Near Threatened (Birdlife International 2001).

Other wildlife unique to the region encompasses the sanctuary such as Jackal, Himalayan serow, Yellow throated marten, Himalayan barking deer, Himalayan goral, Himalayan palm civet, Pika, Himalayan black bear, Red fox and Jackal. Habitat of *Ochoto madaaurica* (Pika) was recorded. Many of the faunal species are listed in the IUCN Red Data Book. Some of the animals have also been included in Schedule I of the Wildlife (Protection) Act, 1972. This region of the Central Himalayas lies within the Eastern Himalayas Endemic Bird Area (EBA) and for several bird species were found in this region.



**Fig 11:** Laughing thrush (feathers)



**Fig 12:**Deer (pellets)



**Fig 13:**Warbler chick found during trial sampling



**Fig 14:**Fox(scats)

#### **CONSERVATION RECOMMENDATION**

As per the survey along the trekking route, sanctuary is endowed with rich biodiversity, covering an area of 35 sq. km. Government of Sikkim proposed construction of the 22 kilometers rope way from Maenam Wildlife Sanctuary to be the first wildlife skywalk in India which will be built over the edge of the Bhaley Dunga steep face. The major threat of biodiversity loss is the

rapid increases by tourist flow along the trekking route. Maenam Wildlife Sanctuary has unique biodiversity and is considered as a biodiversity hotspot that requires instantaneous conservation.

<b>Table 2: Checklist of floral species encountered along the Sampling path</b>			
	<b>Scientific Name</b>	<b>Local Name</b>	<b>Family</b>
<b>TREE / SMALL TREE</b>			
1.	<i>Abies densa</i> Griff.	Gobresalla	Pinaceae
2.	<i>Acer caudatum</i> Wallich	Kapasey	Aceraceae
3.	<i>Acer palmatum</i>	Kapasey	Aceraceae
4.	<i>Berberis insignis</i>	Chutro	Berberidaceae
5.	<i>Betula alnoides</i>	Saur	Betulaceae
6.	<i>Castanopsis tribuloides</i>	MusreyKatus	Fagaceae
7.	<i>Daphne cannabina</i>	Kaloalgeri	Thymelaceae
8.	<i>Daphniphyllumhimalayense</i>	Lall Chandan	Euphorbiaceae
9.	<i>Eurya acuminata</i>	Jhinganey	Theaceae
10.	<i>Ilex</i> sp.	Lise	Aquifoliaceae
11.	<i>Lithocarpus pachyphylla</i>	Sungureykatush	Fagaceae
12.	<i>Litsaeaelongata</i>	Siltimmur	Lauraceae
13.	<i>Lyonia ovalifolia</i>	Angeri	Ericaceae
14.	<i>Machilus</i> sp.	Kawlo	Lauraceae
15.	<i>Machilus edulis</i>	Pomsi	Lauraceae
16.	<i>Machilus odoratissima</i>	LaliKawlo	Lauraceae
17.	<i>Magnolia campbellii</i>	Ghogey champ	Magnoliaceae
18.	<i>Magnolia doltsopa</i>	Rani champ	Magnoliaceae
19.	<i>Magnolia velutina</i>	Phusray champ	Magnoliaceae
20.	<i>Pieris</i> sp.	Lekhangeri	Ericaceae
21.	<i>Prunus nepalensis</i>	Arupatey	Rosaceae
22.	<i>Quercus lamellosa</i>	Bajranth	Fagaceae
23.	<i>Rhododendron arboreum</i>	LaliGurans	Ericaceae
24.	<i>Rhododendron barbatum</i>	Lal Chimal	Ericaceae
25.	<i>Rhododendron falconeri</i>	Korlinga	Ericaceae
26.	<i>Rhododendron grande</i>	Korlinga	Ericaceae
27.	<i>Rhododendron griffithianum</i>	Gurans	Ericaceae
28.	<i>Rhododendron hodgsonii</i>	Korlinga	Ericaceae
29.	<i>Saurauianapaulensis</i>	Gagun	Actinidiaceae
30.	<i>Sorbus cuspidata</i> Hedlund.	Pasi	Rosaceae
31.	<i>Symplocos glomerata</i> King	Kholmay	Symplocaceae
32.	<i>Symplocos lucida</i> D. Don	Kharanay	Symplocaceae
<b>SHRUBS</b>			
1.	<i>Actinodaphne sikkimensis</i>	Phirphirey	Lauraceae
2.	<i>Boehmariaplatyphylla</i> D. Don	Kamley	Urticaceae
3.	<i>Daphne cannabina</i> Wall.	Kaloargayle/Loktee	Thymelaeaceae



4.	<i>Dichroafebrifuga</i> Lour.	Basak	Hydrangaceae
5.	<i>Edgeworthiagardneri</i> Meissn.	Argayle/Kagate	Thymelaeaceae
6.	<i>Gaultheria hookeri</i> Clarke	Dhasingre	Ericaceae
7.	<i>Gaultheria nummulariodes</i>	Dhasingre	Ericaceae
8.	<i>Neilliarubiflora</i>	Kirkeray	Rosaceae
9.	<i>Osbeckia stellata</i>	Chulesi	Melastomataceae
10.	<i>Oxysporapaniculata</i>		Melastomataceae
11.	<i>Rhododendron camelliflorum</i>	Chia phulegurans	Ericaceae
12.	<i>Rubus ellipticus</i>	Ainselu	Rosaceae
13.	<i>Rubus lineatus</i>	Ainselu	Rosaceae
14.	<i>Rubus nevius</i>		Rosaceae
15.	<i>Vaccinium retusum</i>	Mussikane	Ericaceae
16.	<i>Viburnum erubescence</i>	Asaray	Caprifoliaceae
<b>HERBS</b>			
1.	<i>Aeschynanthus hookeri</i>	Baklaypatay	Geraniaceae
2.	<i>Aeschynanthus parviflorus</i>	Baklaypatay	Gesneriaceae
3.	<i>Aeschynanthus sikkimensis</i>		Gesneriaceae
4.	<i>Ageratum conyzoides</i>		Asteraceae
5.	<i>Ainsliaeaaptera</i>		Asteraceae
6.	<i>Ajuga lobata</i>		Lamiaceae
7.	<i>Anaphalis triplinervis</i>	BukiPhool	Asteraceae
8.	<i>Anaphalis virgata</i>	Bukiphul	Asteraceae
9.	<i>Arisaema concinuum</i>	Laura/Baako	Araceae
10.	<i>Arisaema consanguineum</i>	Laura/Baako	Araceae
11.	<i>Arisaema erubescens</i>	Baako	Araceae
12.	<i>Arisaema nepenthoides</i>	Laura/Baako	Araceae
13.	<i>Astilberivularis</i>	Buriokhati	Saxifragaceae
14.	<i>Begonia sp.</i>	Magarkachi	Asteraceae
15.	<i>Bidens pilosa</i>	Kuro	Asteraceae
16.	<i>Bistorta affinis</i>		Polygonaceae
17.	<i>Campylandraaurantica</i>	JangleeNakima	Liliaceae
18.	<i>Cautleya spicata</i> – (J. M. Sm.) Bak	Sara	Zingiberaceae
19.	<i>Centellaasiatica</i> (L.) Urban	Golpatta	Apiaceae
20.	<i>Cheilocostus speciosus</i>	Beethlauri	Costaceae
21.	<i>Chirita pumila</i>		Gesneriaceae
22.	<i>Chiritaurticifolia</i>		Gesneriaceae
23.	<i>Crassocephalumcrepidiodes</i>		Asteraceae
24.	<i>Cremanthodiumreniforme</i>		Asteraceae
25.	<i>Cyanotisvaga</i>	KanayJahr	Commelinaceae
26.	<i>Cyanotisvaga</i> (Lour.) Schult. &Schult.f.		Commelinaceae
27.	<i>Cynodondactylon</i>	Dubo	Poaceae
28.	<i>Dichroafebrifuga</i>	Basak	Hydrangeaceae

29.	<i>Diphylax sp.</i>		Orchidaceae
30.	<i>Drymariacordata</i>	Abijalo	Caryophyllaceae
31.	<i>Elatostemaplatyphyllum</i>	Gagleto	Urticaceae
32.	<i>Elatostemaplatyphyllum</i> Weddell.	Gagleto	Urticaceae
33.	<i>Elatostema sessile</i> J.R.Forst. &G.Forst.	Gagleto	Urticaceae
34.	<i>Epilobium</i> sp.		Onagraceae
35.	<i>Eragrostis cilianensis</i> (All.) Lut. ex	Banso	Poaceae
36.	<i>Eragrostis sp.</i>	Kirkireybanso	Poaceae
37.	<i>Eragrostis sp.</i>	Chitreybanso	Poaceae
38.	<i>Eragrostis sp.</i>	Banso	Poaceae
39.	<i>Eupatorium adenophorum</i> Spreng.	Kali jhar	Asteraceae
40.	<i>Fragaria nubicola</i>	VuiAiselu	Rosaceae
41.	<i>Fragaria nubicola</i> Lindley ex. Lacaita	Bhui-aiselu	Rosaceae
42.	<i>Galinsoga parviflora</i>		Asteraceae
43.	<i>Galium sp.</i>		Rubiaceae
44.	<i>Geranium sp.</i>		Geraniaceae
45.	<i>Gerardianadiversifolia</i> (Link) Friis	Bhangresisnu	Urticaceae
46.	<i>Gonatanthuspumilus</i>		Araceae
47.	<i>Hackelia</i> sp.	Kuro	Boraginaceae
48.	<i>Hedychium spicatum</i>	Ham Saro	Zingiberaceae
49.	<i>Hemiphragmaheterophyllum</i>		Scrophulariaceae
50.	<i>Hypericum sp.</i>		Guttiferae
51.	<i>Impatiens sp.</i>		Balsaminaceae
52.	<i>Juncus sp.</i>		Juncaceae
53.	<i>Laportea terminalis</i>	Patlesisnu	Urticaceae
54.	<i>Mussaendaroxburghii</i>	Dhobi Phul	Rubiaceae
55.	<i>Nepeta sp.</i>		Lamiaceae
56.	<i>Oxalis corniculata</i>	Amilojhar	Oxalidaceae
57.	<i>Persicaria capitata</i>	Gross Ratneulo	Polygonaceae
58.	<i>persicariaruncinata</i>	Ratnaulo	Polygonaceae
59.	<i>Pileascripta</i>		Ulmaceae
60.	<i>Pileaumbrosa</i> Blume.	Chiple	Urticaceae
61.	<i>Poa sp.</i>		Poaceae
62.	<i>Polygonum molle</i>	Thotney	Polygonaceae
63.	<i>Polygonum runcinatum</i>	Ratnaulo	Polygonaceae
64.	<i>Rumex nepalensis</i>	Halhalley	Polygonaceae
65.	<i>Selinum sp.</i>		Apiaceae
66.	<i>Swertia bimaculata</i>	BhaleChirowto	Gentianaceae
67.	<i>Swertia chirayita</i>	Chirowto	Gentianaceae
68.	<i>Urticadioica</i> Linn.	GariaSisnu	Urticaceae
<b>CLIMBERS</b>			

1.	<i>Crawfurdiaspeciosa</i>		Gentianaceae
2.	<i>Dactylicapnos scandens</i>		Papaveraceae
3.	<i>Herpertospermum pedunculatum</i>		Cucurbitaceae
4.	<i>Holboellia angustifolia</i>	Gulfa	Lardizabalaceae
5.	<i>Piper sp.</i>		Piperaceae
6.	<i>Rhaphidophoradecursiva</i>	Kanchirno	Araceae
7.	<i>Rhaphidophora sp.</i>	Kanchirno	Araceae
8.	<i>Rubiaccordifolia</i>	Manjith	Rubiaceae
9.	<i>Smilax aspera</i>		Liliaceae
10.	<i>Stephania sp.</i>		Menispermaceae
11.	<i>Tetrastigmaserrulatum</i>		Vitaceae
12.	<i>Viscum articulatum</i> Burm. F.		Santaceae
<b>FERNS AND FERN-ALLIES</b>			
1.	<i>Araiostegiabeddomei</i>		Davalliaceae
2.	<i>Asplenium ensiforme</i>		Aspleniaceae
3.	<i>Asplenium lacinatam</i>		Aspleniaceae
4.	<i>Angiopteris indica</i>		Marattiaceae
5.	<i>Coniogramme intermedia</i>		Pteridaceae
6.	<i>Dryopteris sikkimensis</i>	SottarUnew	Dryopteraceae
7.	<i>Lycopodiallacernua</i>	Nagbeli	Lycopodiaceae
8.	<i>Monachosoramhenryi</i>		Monachosoraceae
9.	<i>Plagiogyriapycnophylla</i>		Plagiogyriaceae
10.	<i>Selaginella sp.</i>		Selaginellaceae
11.	<i>Sphagnum sp.</i>		Sphagnaceae
12.	<i>Gleicheniagiganteam</i>		Gleicheniaceae
13.	<i>Peranemacyatheoides</i>		Dryopteridaceae
14.	<i>Dryopteris redactopinnata</i>		Dryopteridaceae
15.	<i>Histiopterisincisa</i>		Dennstaedtiaceae
16.	<i>Diplazium esculentum</i>		Woodsiaceae
<b>ORCHID</b>			
1.	<i>Satyrium nepalensis</i>		Orchidaceae
2.	<i>Cymbidium erythraeum</i> Lindl.		Orchidaceae
3.	<i>Bulbophyllum sp.</i>		Orchidaceae
4.	<i>Dendrobium sp.</i>		Orchidaceae
<b>BAMBOO</b>			
1.	<i>Sinarundinaria intermedia</i>	nigalo	
2.	<i>Yushania maling</i>	milango	



**Table 3: Checklist of avi-faunal species encountered along the sampling path**

	Scientific Name	Common Name	Family
Sl. No	<i>Actinodura nipalensis</i>	Hoary Throated Barwing	Leiothrichidae
1.	<i>Aethopyga nipalensis</i>	Green tailed Sunbird	Nectariniidae
2.	<i>Chaimarrornis leucocephalus</i>	White capped Redstart	Muscicapidae
3.	<i>Copsychus saularis</i>	Orietal Magpie Robin	Muscicapidae
4.	<i>Corvus macrorhynchos</i>	Large billed crow	Corvidae
5.	<i>Eumyias thalassinus</i>	Verditer Flycatcher	Muscicapidae
6.	<i>Fulvetta vinipectus</i>	White Browed Fulvetta	Timaliidae
7.	<i>Lanius tephronotus</i>	Grey backed Shrike	Laniidae
8.	<i>Leiothrix lutea</i>	Red billed Leiothrix	Leiothrichidae
9.	<i>Lophura leucomelanos</i>	Kalij Pheasant	Phasianidae
10.	<i>Malaciascapistratus</i>	Rufous Sibia	Leiothrichidae
11.	<i>Minla ignotincta</i>	Red tailed Minla	Leiothrichidae
12.	<i>Myzornis pyrrhoura</i>	Fire tailed Myzornis	Timaliidae
13.	<i>Orthotomus atrogularis</i>	Common Tailor bird	Cisticolidae
14.	<i>Parus monticulus</i>	Green Backed Tit	Paridae
15.	<i>Pericrocotus (flammeus) speciosus</i>	Scarlet Minivet	Campephigidae
16.	<i>Picus flavinucha</i>	Greater Yellownappe	Picidae
17.	<i>Pycnonotus cafer</i>	Red vented Bulbull	Pycnonotidae
18.	<i>Rhipidura aureola</i>	White browed Fantail	Rhipiduridae
19.	<i>Streptopelia orientalis</i>	Oriental Turtle Dove	Columbidae
20.	<i>Tragopan satyra</i>	Satyr Tragopan	Phasianidae
21.	<i>Treron sphenurus</i>	Wedge-tailed Green Pigeon	Columbidae
22.	<i>Yuhina flavicollis</i>	Whiskered Yuhina	Zosteropidae
23.	<i>Zoothera dauma</i>	Scaly Thrush	Turdidae

**Table 4: Checklist of faunal species along the sampling path**

24.	<i>Ursus thibetanus</i>	Himalayan black bear	Ursidae
25.	<i>Muntiacus muntjak</i>	Himalayan barking deer	Cervidae
26.	<i>Ochotona sp.</i>	Pika	Ochotonidae
27.	<i>Martes flavigula</i>	Yellow Throated Marten	Mustelidae
28.	<i>Panthera pardus</i>	Common leopard	Felidae
29.	<i>Paradoxurus sp.</i>	Civet	Viverridae
30.	<i>Ailurus fulgens</i>	Red panda	Ailuridae
31.	<i>Naemorhedus goral</i>	Goral	Bovidae
32.	<i>Capricornis thar</i>	Serow	Bovidae
33.	<i>Vulpes vulpes</i>	Red fox	Canidae

*Rhododendron niveum*

**Snow-leaved Rhododendron  
Hiun pate gurans**



**The State tree of Sikkim**

# MONITORING OF BIODIVERSITY OF YAKCHEY TO SHINGBA RHODODENDRON SANCTUARY IN NORTH SIKKIM

Anjana Pradhan and Dorjee C. Bhutia

## INTRODUCTION

Yakchey is a picturesque region that expands from Lachung village to the Shingba Rhododendron Sanctuary casing a vast range of floral structure from Rhododendrons to trees of timber-yielding and ornamentals to herbal plants to beautiful flowery shrubs. The topographical aspect of the region is located between 27°42'45.0"N – 88°44'57.3"E and 27°43'39.3"N – 88°44'32.9"E stretching from an altitude of 2800m – 3200m asl. The geography of the region is entwined from jungle clad ridges and deep ravines to bright green valleys. With just a difference of about 346m elevation gradient, the forest harbours a range of vegetation characterizing forest types of temperate coniferous to sub-alpine. The climate of the region is usually long moist season followed by dry spell during the winters. Snow is common from November to January while monsoon brings heavy rainfall constantly offering small landslips and occasional avalanches. This area can be reached from Lachung village.

## RAPID BIODIVERSITY SURVEY

This report highlights the Rapid Biodiversity Survey (RBS) by resurveying the sampled plots of Yakchey - Shingba Rhododendron Sanctuary sampling path in North Sikkim focusing on the vegetation changes observed during the last 5 years. Previous RBS study was conducted in May 2014 with a recording of 75 species. In a span of 5 years' time, the present (Revisit) study was conducted in May 2019 covering a distance of 7km along the 27 random sampling plots of 0.27ha area. The elevation of the study site ranged between 2876m and 3222m asl showing aspects of East, North and North-East with slope angle falling between 5 and 45 degree inclination.

## FOREST TYPE

The types of forest covered in the present study were temperate coniferous to sub-alpine forests. The topmost canopy of the temperate coniferous forest was dominated with conifer species of *Abies densa*, *Cupressus torulosa*, *Juniperus recurva*, *Larix griffithiana*, *Picea spinulosa* and *Tsuga dumosa* supporting the temperate coniferous tree vegetation. While other conifers are distributed regularly across the forest, *Cupressus torulosa* was scarcely distributed. These conifer species are found at the upper reaches of the forest (2919m – 3216m) covering the sub-alpine forest also. Other associating trees inhabiting the forest are *Acer campbellii*, *A. caudatum*, *Betula utilis*, *Daphniphyllum himalense*, *Maddenia himalaica*, *Populus jacquemontiana*, *Pieris ovalifolia*, *Prunus cornuta*, *Salix* sp., *S. longiflora*, *Sorbus* sp. and *Magnolia globosa*. *Prunus cornuta* was observed only at one area growing in the vicinity of *Hippophae salicifolia* and *Lyonia ovalifolia*.

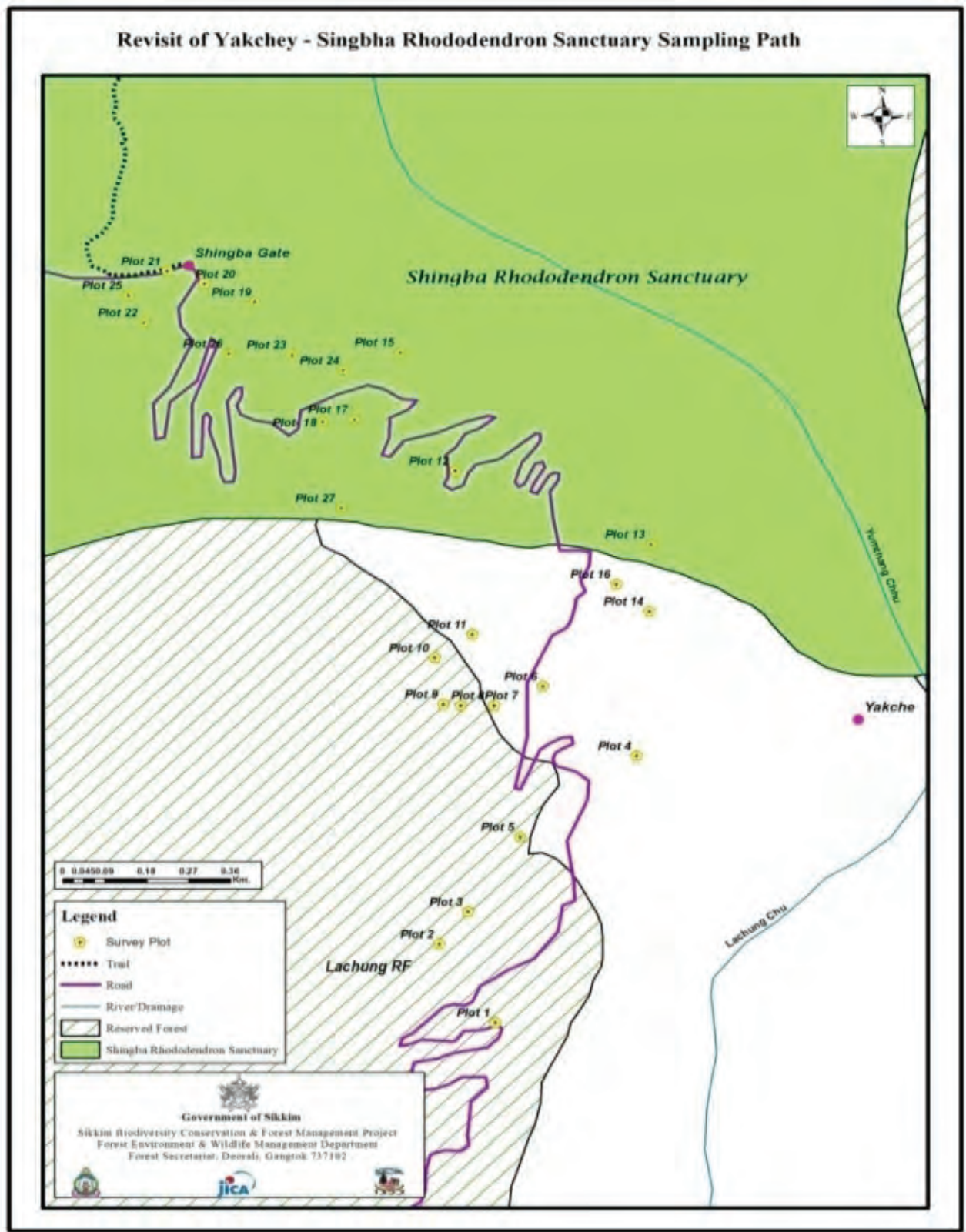




**A:** Temperate coniferous forest depicting the topmost canopy



**B:** Sub-alpine forest



C: Map showing the Rapid Biodiversity Survey plots for Revisit of Yakchey – Shingba Rhododendron Sanctuary sampling path



## FIELD ACTIVITY

All the geo-tagged 27 sampled plots were revisited by recording the tree, sapling, seedling, shrub and herb species following the RBS methodology.



**D:** Field activities conducted during the survey by the BC Survey team

**Below are the site characteristics of the sampling path (Table 1)**



<b>Table 1: Site characteristics of sampled plots of Yakchey – Shingba RS Sampling Path</b>				
<b>Site</b>	<b>Forest Type</b>	<b>Latitude (E)</b>	<b>Longitude (N)</b>	<b>Elevation(m)</b>
YS 1	Temperate Conifer	27°42'45.0"	88°44'57.3"	2876
YS 2	Temperate Conifer	27°42'51.1"	88°44'53.4"	2931
YS 3	Temperate Conifer	27°42'53.6"	88°44'55.4"	2950
YS 4	Temperate Conifer	27°43'05.7"	88°44'07.1"	2919
YS 5	Temperate Conifer	27°42'59.4"	88°44'59.0"	2937
YS 6	Temperate Conifer	27°43'11.1"	88°44'00.6"	3048
YS 7	Temperate Conifer	27°43'09.6"	88°44'57.2"	3003
YS 8	Temperate Conifer	27°43'09.6"	88°44'54.9"	3016
YS 9	Temperate Conifer	27°43'09.7"	88°44'53.7"	3044
YS 10	Temperate Conifer	27°43'13.3"	88°44'53.1"	3005
YS 11	Temperate Conifer	27°43'15.1"	88°44'55.7"	3012
YS 12	Temperate Conifer	27°43'27.8"	88°44'54.5"	3046
YS 13	Temperate Conifer	27°43'22.1"	88°44'08.1"	2977
YS 14	Temperate Conifer	27°43'16.9"	88°44'08.0"	2952
YS 15	Temperate Conifer	27°43'37.0"	88°44'50.7"	3099
YS 16	Temperate Conifer	27°43'19.0"	88°44'05.7"	2964
YS 17	Temperate Conifer	27°43'31.8"	88°44'47.5"	3097
YS 18	Sub Alpine Forest	27°43'31.6"	88°44'45.3"	3114
YS 19	Temperate Conifer	27°43'40.9"	88°44'40.6"	3148
YS 20	Temperate Conifer	27°43'42.3"	88°44'37.1"	3202
YS 21	Temperate Conifer	27°43'43.3"	88°44'34.5"	3216
YS 22	Sub Alpine Forest	27°43'39.3"	88°44'32.9"	3222
YS 23	Sub Alpine Forest	27°43'36.8"	88°44'43.2"	3220
YS 24	Sub Alpine Forest	27°43'35.6"	88°44'46.7"	3101
YS 25	Sub Alpine Forest	27°43'41.4"	88°44'31.8"	3116
YS 26	Sub Alpine Forest	27°43'36.9"	88°44'38.8"	3148
YS 27	Sub Alpine Forest	27°43'24.9"	88°44'46.6"	3081

## **FINDINGS AND DISCUSSIONS**

### **NUMERICAL STRENGTH OF THE FLORA**

During the revisit survey, a few floral species have been recorded which were otherwise not recorded in the previous visit. The revisit study revealed a general checklist of 133 species out of which 89 species were recorded within the plots (Table 2). Seventy-six genera belonging to 54 families of floral species were recorded in the present study of which herb represented the highest number of species with 42 species belonging to 39 genera in 27 families. This was followed by shrub/scrub (19 species, 12 genera in 7 families), large trees (11 species, 10 genera in 8 families), small tree/large shrubs (10 species, 8 genera in 6 families) and ferns and fern-allies (7 species, 7 genera in 6 families). Ericaceae and Rosaceae were the dominant family representing rhododendrons and potentilla and prunus, respectively.

Species	Previous Study				Present Study			
	Within plot	Genus	Family	General	Within plot	Genus	Family	General
Large tree	11	10	8	11	11	10	8	16
Small tree/Large shrub	8	8	6	9	10	8	6	15
Small shrub/scrub	14	13	8	20	19	12	7	22
Herb	36	31	22	64	42	39	27	67
Fern & Fern-allies	6	6	5	6	7	7	6	7
Bamboo	0	0	0	1	0	0	0	1
Climbers and epiphytes	0	0	0	5	0	0	0	5
<b>Total</b>	<b>75</b>	<b>68</b>	<b>49</b>	<b>116</b>	<b>89</b>	<b>76</b>	<b>54</b>	<b>133</b>

### **SOME BIODIVERSITY FINDINGS/CHANGES OBSERVED**

After a gap of 5 years, monitoring of biodiversity was conducted in the month of May 2019 to check the availability and variability of the species and to determine the current distribution of species. Major change observed was in the landform of localized areas which was caused due to landslides, small landslips and construction of army settlements that were sampled in the previous study. Some areas have become a drill area of army; fencing has been done in larger part of the area; and garage for vehicles and tanks have been set up. Hence, there has been some loss in the biodiversity and the landscape of the area. No new growth of vegetation was observed at such areas apart from weeds and only few species of rhododendrons were seen to be protruding through the harsh destructed areas.

Fourteen rhododendron species are found in Yakchey out of which 8 species are recorded within the plots. Amongst the rhododendron species, an endemic tree and flagship species of the state, *Rhododendron niveum*, is available in the forest of Yakchey upto Shingba Rhododendron Sanctuary. It was observed that the regeneration status, in the form of seedlings/saplings, was comparatively more in number to the previous study; and dense clumps of the species were seen regularly distributed in the area especially near roadside. Nevertheless, altogether, human interferences like constructions of army settlements and drill areas have led to the degradation of its habitat as was observed during the revisit. Natural disturbances like landslide and small landslips have also added to tremendous damage to the natural habitat of *R. niveum* leading to its population loss. In some areas, few *R. niveum* trees were seen uprooted adding to the loss of individual tree species as well.



**A:** Landslide in *Rhododendron niveum* habitat;



**B:** Uprooted *R. niveum* tree

Apart from *Rhododendron arboreum* and *R. hodgsonii*, other rhododendron species were found in the area. The vulnerable *R. arboreum* is widely distributed in the temperate forest and is found in association with conifer species. *Rhododendron ciliatum*, *R. cinnabarinum*, *R. lepidotum*, *R. thomsonii* and *R. glaucophyllum* were recorded during the revisit survey. These species were widely found along 3110m upto 3200m. While *R. glaucophyllum* and *R. ciliatum* were distributed along 3100m upto 3200masl, *R. cinnabarinum* was found at irregular patches across 3100m elevation gradient which is also well distributed in Shingba RS.



### ***Endemic, Endangered and Threatened Rhododendrons of Sikkim encountered***



***Rhododendron ciliatum***, an endemic species of the Eastern Himalayas, is reported to be threatened in Sikkim. However, it is found to be growing widely in the northern part of Sikkim from Thangu to Lachen, Lachung – Yakchey – Shingba RS, Tholung – Kishong and in Yuksom – Dzungri in west Sikkim as reported by RBS study. It was observed inhabiting wet and moist or marshy ground in association with *R. glaucophyllum*, *R. lepidotum* and reported to be in association with *R. thomsonii*, *R. baileyi* and *R. niveum*.

Local name: JungeChimal; Common name: Ciliated Rhododendron



***Rhododendron glaucophyllum*** was first described by J.D. Hooker as *R. glaucum*. This species was in full bloom growing in association especially with *R. ciliatum* and *R. lepidotum* along the sampling path of Yakchey area. It was also found to be growing in association with *R. niveum* and *Juniperus recurva* at some places. This species is found in the inner forests of Shingba RS and Tholung – Kishong and Thangu to Lachen stretch as well. It is an endemic species of the Eastern Himalayas and is widely available in the northern part of Sikkim.

Local name: Takmachimal

Common name: Glaucous-leaved Rhododendron



***Rhododendron niveum***, an endangered bushy shrub or small tree in Sikkim is distributed at localized areas within 3000m – 3500m asl at Yakchey – Shingba RS and along the stretch of Tholung – Kishong route. It is found to be growing in open rocky slope in association with other *R. ciliatum*, *R. glaucophyllum*, *R. cinnabarinum*, *R. thomsonii* and *Juniperus recurva*. This species is considered to be the most beautiful amongst the rhododendron species with lilac-purple flowers and dull green foliage having creamish white undersurface and was declared as the State flower of Sikkim; and is the flagship species of the State. Local name: Hiun pate gurans; Common name: Snow-leaved Rhododendron



*Rhododendron triflorum* is a shrubby bush scattered in rocky sub-alpine slopes in association with *R. lepidotum*, *R. thomsonii* and *R. baileyi*. Its population as observed was very less in number and could be seen only at slopes. This species has been recorded in Yakchey area, Lachung and Lachen valleys and hence threatened in Sikkim.

Local name: Pahenlegurans

Common name: Three-flowered Rhododendron



*Rhododendron pendulum* was first described by Hooker in 1849 from Lachen in North Sikkim. This species was found growing as a small straggling epiphytic shrub on big rocks with trailing branchlets covered with dense wooly hairs. It grows in association with other rhododendron-Abies. It flowers in May flushed with yellow spots at the throat. This species is found at Yakchey upto Yumthang valley from 2500m to 3800m asl. It has also been recorded in Tholung – Kishong and Tshoka – Dzongri.

Local name: JhundinaeChimal; Common name: Pendulous Rhododendron



**A:** *Rhododendron arboreum* forest; **B:** Rhododendron species habitat in association with *R. niveum*, *R. glaucophyllum*, *R. cinnabarinum* and *R. thomsonii* in sub-alpine zone



As rhododendrons are widely distributed along the temperate and sub-alpine forest, it provides habitat for a variety of plants and animals including avifauna. With disturbances in the forest, it degrades the habitat which in turn threatens the associated biodiversity. Hence, maintaining and conserving the species promotes the existence of other biodiversity components. It provides food reserve for a wide range of birds at an altitudinal gradient as well.



**A:** Fire-tailed sunbird and **B:** Long-tailed shrike on *Rhododendron arboreum* tree



*Hippophae salicifolia* in its late ripening stage



*Hippophaesalicifolia*, commonly known as Sea buckthorn and locally called as Tarwa or Taruba, is densely distributed along the roadside and inside the forest below 3000m asl growing in association with *Picea spinulosa*, *Salix longiflora*, *Lyonia ovalifolia*, *Rhododendron arboreum* and *Populusjacquemontiana*. The distribution of the species is restricted in Lachen and Lachung valleys at altitudes from 2377m to 3093m asl mostly facing South-East aspect. In Sikkim, the flowering starts in the month of March for a week to 10 days and fruiting starts from April, ripens during late October to November and retains till March-April. The berries at the time of visit were at its late ripening stage. This species is ecologically, medicinally and economically important. The ability to develop extensive root system rapidly makes this species an ideal plant in such an area to prevent soil erosion and land reclamation. The fruits are rich in carbohydrates, protein and vitamins that are worldwide extracted to make tonics and syrups for health benefits. Locally, the leaves of the plant is dried and used for making tea by the villagers. The berries are also commercially used in various beautification products that have gained popularity. This highly valuable species deserves large scale plantation (ex- and in-situ) for future conservation and management due to its localized habitat.



*Maddeniahimalaica*

*Maddeniahimalaica*, an endemic to eastern Himalaya species is also found in the area along 2876m – 3012m asl in temperate forest. It was found in association with

*Daphniphyllumhimalense* and *R. arboreum*. The associated ground vegetation observed were *Artemisia wallichii*, *Rubus* sp., *Rubiamanjith*, *Gaultheria nummularoides*, etc. It flowers in April – May.



**A:** Flowering of *Salix longiflora*; **B:** *Populus jacquemontiana*;  
**C:** Flowering of *Prunus cornuta*; **D:** Flowering of *Lyonia ovalifolia*

About 76 herb species covered the ground vegetation with widely distributed species being that of *Fragaria nubicola*, *Arisaema griffithii*, *Anaphalis triplinervis*, *Eragrostiscilianensis*, *Euphorbia sikkimensis*, *Hemiphragma heterophyllum*, *Polygonatum multiflorum*, *Potentilla* sp., *Primula denticulata*, *Juncus thomsonii*, *Clintonia udensis*, etc. *Androsa cerotundifolia*, *Arisaema nepenthoides*, *Gentiana pedicellata*, *Lysimachia prolifera*, *Portulaca* sp., *Saxifraga* sp., *Veronica serpyllifolia* and *Viola pilosa* were other species recorded in this visit.





*Viola biflora*



*Viola pilosa*



*Lysimachiaprolifera*

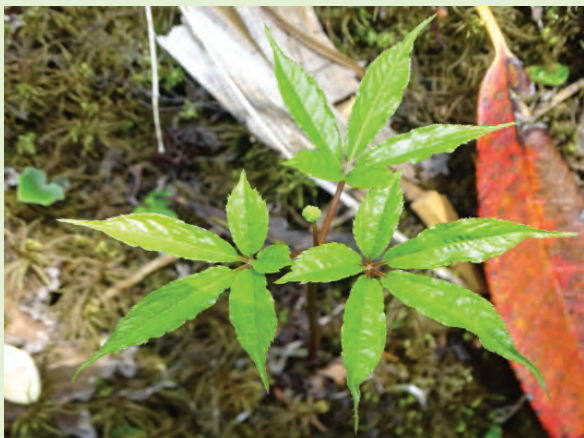


*Veronica serpyllifolia*

Medicinal herbs like *Astilberivularis*, *Artemisia wallichiana*, *Paris polyphylla*, *Panax pseudoginseng*, *Cardaminemacrophylla* and *Cardiocrinum giganteum* are the common species of the forest. *Panax bipinnatifidus* was not recorded in this visit. This may probably be due its previous habitat location being destructed or its species being degraded over a span of 5 years. Distribution of *Paris polyphylla* (Satuwa) and *Panax pseudoginseng* was restricted to certain areas in the sampled plots. Although they showed population occurrence at study sites around 2876m – 3046m asl, their number was low in a group of 5 – 10 individuals in a plot which is comparatively lower to the previous study. *Paris polyphylla* was seen flourishing under the canopy of moist temperate forest harbouring associated species of *Artemisia*, *Viburnum erubescens*, *Lycopodium*, *Arisaema*, ferns and *Fragaria*. *Panax pseudoginseng* was seen to be



growing on almost bare-dry ground in association with *Fragaria nubicola* and *Lycopodium* sp. The low number in the occurrence of species may be due to human encroachment and the landslips that have occurred leading to the reduction in its habitat.



*Panax pseudoginseng*



Flowering of *Paris polyphylla*



*Cardiocrinum giganteum* Rubiamanjith



*Viburnum erubescens*, *Daphne cannabina*, *Rosa sericea*, *Berberis asiatica*, *Gaultheria nummularioides*, *Rhododendron lanatum*, *Ribes griffithii*, *R. himalense*, *Rubus* sp., *Piptanthus nepalensis*, *Cotoneaster microphyllus*, *Salix calyculata*, *S. wallichiana* and *Enkianthus deflexus* are the commonly found shrubs in the area. *Berberis jaeschkeana* and *Gaultheria hookeri* are other shrubs recorded in this visit. It was found that *Pleione hookeriana*, the highest growing orchid species, which grew favorably in the branches of *Tsuga dumosa* in the previous study, could not be recorded in this visit.





*Berberis jaeschkeana* *Gaultheria hookeri*

## FAUNAL SPECIES

During the survey, few species of birds and butterflies were encountered and reported in the Yakchey area sampling path. Some of them were directly sighted and photographs were taken which are presented below.



White-collared blackbird and Black bulbul



**Rosy pipit and White-capped water redstart**



**Queen of Spain Fritillary and Indian Tortoise Shell**

<b>Table 3: Checklist of avi-faunal species encountered along the sampling path</b>	
<b>Common Name</b>	<b>Specific Name</b>
Black bulbull	<i>Hypsipetes leucocephalus</i>
Blue whistling thrush	<i>Myophonus caeruleus</i>
Common myna	<i>Acridotheres tristis</i>
Fire-tailed sunbird	<i>Aethopyga ignicauda</i>
Grey-backed shrike	<i>Lanius tephronotus</i>
Large-billed crow	<i>Corvus macrorhynchos</i>
Leaf warbler	<i>Phylloscopus sp.</i>
Long-tailed shrike	<i>Lanius schach</i>



Oriental turtle dove	<i>Streptopelia orientalis</i>
Snow pigeon	<i>Columba leuconata</i>
Plumbeous water redstart	<i>Rhyacornis fuliginosa</i>
Rufous-vented yuhina	<i>Yuhina occipitalis</i>
Stripe-throated yuhina	<i>Yuhina gularis</i>
White-collared blackbird	<i>Turdus albocinctus</i>

<b>Table 4: Checklist of floral species encountered in the sampling site of Yakchey in North Sikkim</b>					
	<b>TREE SPECIES</b>	<b>Family</b>	<b>Local name</b>	<b>Previous study (May 2014)</b>	<b>Present study (2019)</b>
1	<i>Abies densa</i> Griff.	Pinaceae	Gobre salla	+	+
2	<i>Acer caudatum</i> Wall.	Sapindaceae	Kapasey	+	+
3	<i>Acer campbellii</i> Hook.f. & Thomson ex Hiern	Sapindaceae	Kapasey	+	+
4	<i>Betula utilis</i> D.Don	Betulaceae	Lekh saur	+	+
5	<i>Cupressus torulosa</i> D.Don	Cupressaceae	Raj sallo	+	+
6	<i>Daphniphyllum himalayense</i> (Benth.) Müll.Arg.	Daphniphyllaceae	Lal chandan	+	+
	<i>Juniperus recurva</i>				+
7	<i>Larix griffithii</i> Hook.f.	Pinaceae	Langtang sallo	+	+
8	<i>Lyonia ovalifolia</i> (Wall.) Drude	Ericaceae	Angeri	+	+
9	<i>Magnolia globosa</i> Hook.f. & Thomson	Magnoliaceae	Ghogeys champ	+	+
10	<i>Picea spinulosa</i> (Griffith) Henry	Pinaceae		+	+
11	<i>Populus jacquemontiana</i> Dode	Salicaceae		+	+
12	<i>Prunus bracteopadus</i> Koehne	Rosaceae	Arupatey	+	+
13	<i>Prunus cornuta</i>	Rosaceae		-	+
14	<i>Rhododendron arboreum</i> Sm.	Ericaceae	Lali gurans	+	+
15	<i>Rhododendron barbatum</i> Wall. ex G. Don	Ericaceae	Lal chimal	-	+
16	<i>Rhododendron hodgsonii</i> Hook. f.	Ericaceae	Korlinga	+	+
17	<i>Rhododendron niveum</i> Hook.f.	Ericaceae	Hiun pate gurans	+	+
18	<i>Rhododendron thomsonii</i> Hook.f.	Ericaceae	Dr. thomson ko gurans	-	+
19	<i>Salix longiflora</i> Wall. ex Andersson	Salicaceae		+	+
20	<i>Sorbus ursina</i> (Wall. ex D.Don) Decne.	Rosaceae	Lek pasi	+	+
21	<i>Symplocos glomerata</i>	Symplococaceae		-	+
22	<i>Tsuga dumosa</i> (D.Don) Eichler	Pinaceae	Thengre salla	+	+
<b>SHRUB/SCRUB SPECIES</b>					
1	<i>Berberis asiatica</i> Roxb. ex DC.	Berberidaceae	Chutro	+	+
2	<i>Berberis jaeschkeana</i>	Berberidaceae	Jaeschke's Barberry	-	+
3	<i>Berberis sp.</i>	Berberidaceae	Chutro	-	+

4	<i>Cotoneaster microphyllus</i> Wall. ex Lindl.	Rosaceae		+	+
5	<i>Daphne cannabina</i> Lour. ex. Wall.	Thymelaeaceae	Loktee	+	+
6	<i>Enkianthus deflexus</i> (Griffith) Schneider	Ericaceae		+	+
7	<i>Gaultheria hookeri</i>	Ericaceae	Dhasingre	-	+
8	<i>Hippophae salicifolia</i>	Elaeagnaceae	Chuk, Tarwa; Willow-leaved Sea buckthorn	-	+
9	<i>Ilex sikkimensis</i> Kurz	Aquifoliaceae		+	+
10	<i>Ilex intricata</i>	Aquifoliaceae		+	+
11	<i>Lonicera</i> sp.	Caprifoliaceae		+	+
12	<i>Maddenia himalaica</i> Hook.f. & Thomson	Rosaceae	Himalayan Madden Cherry	-	+
13	<i>Piptanthus nepalensis</i> (Hook.) D.Don	Leguminosae		+	+
14	<i>Prinsepia utilis</i> Royle	Rosaceae		+	+
15	<i>Rhododendron ciliatum</i> Hook. f.	Ericaceae	Junge chimal	-	+
16	<i>Rhododendron cinnabarinum</i> Hook.f.	Ericaceae	Sanu chimal	-	+
17	<i>Rhododendron glaucophyllum</i> Rehder	Ericaceae	Takma chimal	-	+
18	<i>Rhododendron lanatum</i> Hook.f.	Ericaceae	Bhutel chimal	+	+
19	<i>Rhododendron lepidotum</i> Wall. ex G. Don	Ericaceae	Bhale sunpate	-	+
20	<i>Rhododendron niveum</i> Hook.f.	Ericaceae	Huin pate gurans	+	+
21	<i>Rhododendron pendulum</i>	Ericaceae			+
22	<i>Ribes alpestre</i> Wall. ex Decne.	Grossulariaceae		+	+
23	<i>Ribes griffithii</i> Hook. f. & Thomson	Grossulariaceae		+	+
24	<i>Ribes himalense</i> Royle ex Decne.	Grossulariaceae		+	+
25	<i>Rosa sericea</i> Wall. ex Lindl.	Rosaceae		+	+
26	<i>Rubus</i> sp.	Rosaceae		+	+
27	<i>Salix daltoniana</i>	Salicaceae	Bais	+	+
28	<i>Salix</i> sp.	Salicaceae	Bais	-	+
29	<i>Spiraea bella</i> Sims	Rosaceae		+	+
30	<i>Viburnum erubescens</i> Wall.	Adoxaceae	Asare	+	+
<b>HERB SPECIES</b>					
1	<i>Anaphalis triplinervis</i> (Sims) Sims ex C.B.Clarke	Asteraceae	Bukiphool	+	+
2	<i>Androsace rotundifolia</i>	Primulaceae		-	+
3	<i>Anemone</i> sp.	Ranunculaceae		+	+
4	<i>Arisaema griffithii</i> Schott	Araceae	Saap ko phool	+	+
5	<i>Arisaema nepenthoides</i> (Wall.) Mart.	Araceae	Saap ko phool	-	+
6	<i>Artemisia vulgaris</i> L.	Asteraceae	Titey patey	+	+
7	<i>Astilbe rivularis</i> Buch.-Ham. ex D.Don	Saxifragaceae	Buro okhati	+	+
8	<i>Cardamine macrophylla</i> Willd	Brassicaceae	Mangana saag	+	+
9	<i>Cardiocrinum giganteum</i> (Wallich) Makino	Liliaceae		+	+
10	<i>Carex</i> sp.	Cyperaceae	Harkatto	+	+
11	<i>Centella asiatica</i> Linn.	Apiaceae	Golpatta	+	+



12	<i>Circium sp.</i>	Asteraceae		+	+
13	<i>Clintonia udensis Trautv. &amp; Meyer</i>	Liliaceae		+	+
14	<i>Cynodon dactylon</i>	Poaceae		+	+
15	<i>Delphinium sp.</i>	Ranunculaceae		+	-
16	<i>Elsholtzia sp.</i>	Nyctaginaceae		+	+
17	<i>Eragrostis cilianensis</i> (All.) Janch.	Poaceae	Banso	+	+
18	<i>Euphorbia sikkimensis</i> Boiss.	Euphorbiaceae		+	+
19	<i>Euphorbia wallichii</i> Hook.f	Euphorbiaceae		+	+
20	<i>Fragaria nubicola</i> (Lindl. ex Hook.f.) Lacaíta	Rosaceae	Bhui aiselu	+	+
21	<i>Gaultheria nummularioides</i> D. Don	Ericaceae	Dhasingre	+	+
22	<i>Gaultheria tricophylla</i>	Ericaceae	Dhasingre	+	+
23	<i>Galium boreale</i> L. Northern Bedstraw	Rubiaceae		+	+
24	<i>Gentiana pedicellata</i>	Gentianaceae		-	+
25	<i>Geranium sp.</i>	Geraniaceae		+	+
26	<i>Hackelia uncinata</i> (Benth.) C.E.C.Fisch.	Boraginaceae		+	+
27	<i>Hemiphragma heterophyllum</i> Wall.	Plantaginaceae		+	+
28	<i>Heracleum nepalensis</i> D. Don	Apiaceae		+	+
29	<i>Hypericum elodeoides</i> Choisy	Hypericaceae		+	+
30	<i>Impatiens sp.</i>	Balsaminaceae		+	+
31	<i>Juncus himalensis</i> Klotzsch	Juncaceae		+	+
32	<i>Juncus thomsonii</i> Buchenau	Juncaceae		+	+
33	<i>Ligularia fischeri</i> (Ledeb.) Turcz.	Asteraceae		+	+
34	<i>Lysimachia prolifera</i> Klatt	Primulaceae		-	+
35	<i>Mazus dentatus</i> Wallich ex Benth	Scrophulariaceae		+	+
36	<i>Oxalis corniculata</i> L.	Oxalidaceae		+	+
37	<i>Panax bipinnatifidus</i> Seem	Araliaceae		+	+
38	<i>Panax pseudoginseng</i> Wall.	Araliaceae	Ginseng	+	+
39	<i>Paris polyphylla</i> Sm.	Melanthiaceae	Satuwa	+	+
40	<i>Parochetus communis</i> Buch.-Ham. ex D. Don	Fabaceae		+	+
41	<i>Pedicularis elwesii</i> Hook.f	Scrophulariaceae		+	-
42	<i>Pedicularis rhinanthoides</i> Schrenk	Scrophulariaceae		+	-
43	<i>Pedicularis sp.</i>	Scrophulariaceae		-	+
44	<i>Persicaria capitata</i> (Buch.-Ham. ex D. Don) H. Gross	Polygonaceae	Ratnaulo	+	+
45	<i>Persicaria runcinata</i> (Buch.-Ham. ex D. Don) H. Gross	Polygonaceae	Ratnaulo	+	+
46	<i>Pilea scripta</i> Buch.-Ham. ex D. Don	Urticaceae		+	+
47	<i>Pilea umbrosa</i> Blume.	Urticaceae		+	+
48	<i>Poa sp.</i>	Poaceae		+	+
49	<i>Polygonatum multiflorum</i> (L.) All	Liliaceae		+	+
50	<i>Polygonatum prattii</i> Baker	Liliaceae		+	-
51	<i>Portulaca sp.</i>	Portulacaceae		-	+
52	<i>Potentilla cuneata</i> Wallich ex Lehm	Rosaceae		+	+
53	<i>Potentilla fructicosa</i> L.	Rosaceae		+	-

54	<i>Potentilla peduncularis</i> D. Don	Rosaceae		+	+
55	<i>Primula denticulata</i> Smith	Primulaceae		+	+
56	<i>Ranunculus hirtellus</i> Royle	Ranunculaceae		+	+
57	<i>Rheum acuminatum</i> Hook.f. & Thom.	Ranunculaceae		+	+
58	<i>Rhododendron camelliflorum</i>	Ericaceae	Chya phule gurans	+	-
59	<i>Rhododendron triflorum</i> Hook. f.	Ericaceae	Pahenle gurans	+	+
60	<i>Rumex nepalensis</i> Spreng	Polygonaceae	Halhalay	+	+
61	<i>Salvia campanulata</i> Wallich ex Benth	Labiatae		+	-
62	<i>Sambucus adnata</i> Wallich ex DC	Sambucaceae		+	+
63	<i>Saxifraga</i> sp.	Saxifragaceae		-	+
64	<i>Sedum ewersii</i>	Crassulaceae		+	+
65	<i>Sedum</i> sp.	Crassulaceae		+	+
66	<i>Selinum wallichianum</i> (DC.) Raizada & H.O. Saxena	Apiaceae		+	+
67	<i>Smilacina oleracea</i> (Baker) Hook.f	Liliaceae		+	+
68	<i>Smilacina purpurea</i> Wallich	Liliaceae		+	-
69	<i>Streptopus simplex</i> D.Don	Liliaceae		+	+
70	<i>Thalictrum</i> sp.	Ranunculaceae		+	+
71	<i>Trillidium govanianum</i> D. Don	Liliaceae		+	+
72	<i>Triosetum himalayanum</i> Wall	Caprifoliaceae		+	+
73	unidentified			-	+
74	<i>Veronica serpyllifolia</i> L.	Plantaginaceae	Thyme Speedwell	-	+
75	<i>Viola biflora</i> L.	Violaceae		+	+
76	<i>Viola pilosa</i> Blume	Violaceae		-	+
<b>CLIMBERS AND EPIPHYTE SPECIES</b>					
1	<i>Clematis montana</i> Buch.-Ham. ex DC	Ranunculaceae	Pinasay lahara	+	+
2	<i>Rubia manjith</i> Roxb. ex Fleming	Rubiaceae	Majito	+	+
3	<i>Schisandra grandiflora</i> (Wallich) Hook.f. & Thoms	Berberidaceae		+	+
4	<i>Holboellia latifolia</i> Wallich	Lardizabalaceae	Gulfa	+	+
5	<i>Vaccinium nummularia</i> Hook.f. & Thoms	Ericaceae		+	+
<b>BAMBOO SPECIES</b>					
1	<i>Himalayacalamus hookerianus</i>	Poaceae	Pareng	+	+
<b>FERNS AND FERN-ALLIES SPECIES</b>					
1	<i>Lepisorus mehrae</i> Fraser-Jenk	Polypodiaceae	Uniu	+	+
2	<i>Lycopodium japonicum</i> Thunb	Lycopodiaceae	Nagbeli	+	+
3	<i>Odontosoria chinensis</i> (L.) J. Smith	Lindsaeaceae	Uniu	+	+
4	<i>Osmunda claytoniana</i> L.	Osmundaceae	Uniu	+	+
5	<i>Polypodium lachnopus</i> Wall. ex Hook.f.	Polypodiaceae	Uniu	+	+
6	<i>Polystichum</i> sp.	Dryopteridaceae	Uniu	+	+
7	<i>Vittaria</i> sp.	Pteridaceae		-	+

## MAJOR THREATS

A major part of the forest has been destructed by natural disturbances such as that of landslides and small landslips caused due to heavy rainfall at several locations damaging the vegetation composition of the forest. It may be noted that at some places (from 2952m to 3114m) around Plot 4 at an elevation of 2919m (27°43'05.7"N– 88°45'07.1"E), the area has suffered landslide below the road. Such frequent small landslips at places are one of the factors causing loss of biodiversity especially that of rhododendron habitat as observed during the survey.

Anthropogenic disturbances such as grazing and disposal of garbage were observed. There has been displacement and destruction of the species due to human interferences like constructions of army settlements and drill areas which has led to loss of individual *niveum* trees, thereby decreasing the population. Many construction sites have also been established at places which were once a forest-occupied region. The area is permanently fenced as army area and numbers of garages are constructed for tanks and vehicles near the abandoned hut (locally known as Thukchuk's hut). At one place, mature *R. niveum* tree was probably uprooted and sided which could be otherwise planted using the seeds for regeneration at that area or anywhere suitable.

## CONCLUSION AND RECOMMENDATIONS

During the revisit survey, a few floral species have been recorded which were otherwise not recorded in the previous visit. Rhododendron saplings of *R. barbatum* and *R. thomsonii* (red form) were recorded at certain areas especially at around 3200m. Other species like *R. ciliatum*, *R. cinnabarinum* and *R. glaucophyllum* were also recorded in this survey. The forest had good numbers of saplings and seedlings of several tree species of *Abies densa*, *Acer campbellii*, *A. caudatum*, *Rhododendron hodgsonii*, *R. barbatum*, *Tsuga dumosa*, *Populus jacquemontiana* indicating healthy regeneration of the forest despite of several habitat destruction.

During the revisit study, it was found that the occurrence of *Rhododendron niveum* was not good showing low population diversity and its degraded habitat due to natural and anthropogenic pressures. Pradhan and Lachungpa (1990) reported that due to heavy rainfall in 1980 at Yakchey, massive landslides occurred resulting in the degradation of entire population of *R. niveum*. As such its habitat is constantly at pressure and its population is still low for its natural habitat and thus requires high-priority conservation measures. While *R. niveum* trees are localised inside the Shingba RS, good amount of saplings were found in the RF. Since the forest has a diverse number of species, it provides a healthy environment to the other living species that associates with each other providing food and shelter for fauna and avi-fauna species.





**Occurrence of frequent landslips at present; Garbage disposal**



**Natural habitat of *R. niveum* 5 years ago; Disturbed habitat of  
*R. niveum* at present due to construction**

Practice of agrobiodiversity (barley cultivation) inside the RF shows the interdependency of the species in building and sustaining the forest ecosystem. However, such practice is carried out taking into consideration the effects of interference it might cause to the natural biodiversity of the forest. Inside the Reserve Forest, a patch of land is used for barley cultivation as a source of livelihood (after plot 4, 2919m above roadside). This form of agrobiodiversity inside the RF does not interfere with the forest ecosystem but shows a diversified ecosystem.

# MONITORING OF BIODIVERSITY OF TEMPERATE FOREST OF TENDONG RESERVE FOREST IN SOUTH SIKKIM

*Anjana Pradhan and Meena Tamang*



**Usnea sp.**

## INTRODUCTION

Tendong Reserve Forest is located in South District under the South Territorial Division of Namchi. It is a famous tourist destination known for its serene environment and the breathtaking panoramic views of the Eastern Himalayas. It is also considered a historical and religious area as it mounts a monastery at the top of the forest where *Tendong Lho Rum Faat* is celebrated every 8<sup>th</sup> of August. The name “Tendong” is derived from the Lepcha dialect which means “the land of the horn”.

The climate is usually moist characterising the forest as a dense moist temperate broad-leaved domain. The dense RF is dominated by various oak trees of *Castanopsis tribuloides*, *Quercus lamellosa* and *Lithocarpus pachyphyllus*. It also habitats a heritage tree of *Castanopsis hystrix* with the largest CBH of about 21.4ft (6.53m) found in the entire forest. Other commonly found tree species are *Abies densa*, *Acer cappadocicum*, *Cinnamomum* sp., *Exbucklandia populnea*, *Leucoseptrum canum*, *Macaranga pustulata*, *Rhododendron arboreum*, *Symplocos glomerata*, *S. lucida*, etc. Bamboos are encountered along the trek route as well mostly found along the upper part of the forest. Many epiphytic orchids, climbers and ferns can be seen growing on the trees. The forest floor is covered mostly by various species of herbs, shrubs, and ferns. Buttresses at the base of the tree trunk and lianas are the main characteristics of the forest.



The forest is reported to be home to over 90 species of birds namely Blue Whistling Thrush, Common Myna, Himalayan Bulbul, Kaleej Pheasant, Striated Laughingthrush, etc. The forest is also known to be inhabited by Himalayan Black Bear, Serow, Marten, Barking Deer, Red Panda, etc.

## RAPID BIODIVERSITY SURVEY

Monitoring of biodiversity (resurvey) was conducted to resurvey the sampling plots to assess the changes over a period of 3 years (2016). All the 10 geo-tagged sampling plots along the trekking route were resurveyed in 2019 following the RBS methodology. The study area covered the altitude ranging from 2156m to 2626m asl lying between 27°15'0"N – 27°09'0"N latitude and 88°27'0"E – 88°24'0"E longitude (**Map**). The slope angle of the surveyed area ranged from 10° to 60° and aspect facing towards NE, SE and NW (**Table 1**).

Site Code	Forest Type	Altitude (m)	GPS coordinates		Slope Aspect	Slope Angle (°)	Canopy Cover (%)	Anthropogenic disturbance
			Latitude (N)	Longitude (E)				
TH 01	Moist-Temperate Broad-Leaved	2630	27°12'21.5"	88°24'27.1"	N	15	20	Fuelwood/ Fodder
TH 02	Moist-Temperate Broad-Leaved	2594	27°12'28.9"	88°24'30.0"	NE	Mild	30	
TH 03	Moist-Temperate Broad-Leaved	2514	27°12'34.8"	88°24'29.9"	SE	30	45	
TH 04	Moist-Temperate Broad-Leaved	2445	27°12'41.7"	88°24'28.8"	NE	25	65	
TH 05	Moist-Temperate Broad-Leaved	2363	27°12'51.8"	88°24'26.2"	NE	30	60	
TH 06	Moist-Temperate Broad-Leaved	2313	27°13'01.1"	88°24'17.7"	E	15	55	
TH 07	Moist-Temperate Broad-Leaved	2265	27°13'09.2"	88°24'11.6"	SW	30	40	Grazing
TH 08	Moist-Temperate Broad-Leaved	2227	27°13'04.0"	88°24'12.0"	NE	Mild	65	
TH 09	Moist-Temperate Broad-Leaved	2172	27°13'20.0"	88°24'02.2"	NE	15	40	Felling of trees
TH 10	Moist-Temperate Broad-Leaved	2156	27°13'40.5"	88°23'46.0"	NW	40	70	

NOTE: N, North; NE, North-East; SE, South-East; E, East; SW, South-West; NW, North-West









**Walking along the trekking trail of the moist temperate forest**

## **RESULTS**

A total of 173 plant species belonging to 137 genera and 81 families have been recorded at Tendong Reserve Forest combining the two surveys (**Table 2**). Among these, 65 (37.57%) species were represented by herbs, 22 (12.72%) shrubs, 39 (22.54%) trees, 23 (13.29%) ferns and fern-allies, 12 (6.94%) climbers, 10 (5.78%) epiphytes and 2 (1.16%) were bamboo. Of the 173 genera, 147 were angiosperms (126 dicots and 21 monocots), 4 were gymnosperms, 21 pteridophytes and 1 fungus (*Usnea* sp.). In the revisit survey, we recorded 82 species (67 genera and 49 families) more in addition to the 91 species that was enumerated in the first RBS survey conducted in 2016.

The forest was dominated by species of oak with maximum number of *Quercus lamellosa* individuals. The increase in the number of floral species could be due to the plantation of some tree species like *Abies densa*, *Cryptomeria japonica*, *Rhododendron arboreum* and *R. hodgsonii*. Occurrence of other naturally available trees in the forest seemed healthy with regeneration of various tree species along with other floral species adding to the checklist of the area. Invasive species seemed denser than in the previous study supporting the increase in the number of species.



The upper part of the forest was mostly covered by *Yushania maling* (malingo) forming tunnel-like canopy displaying a beautiful pathway along the trekking trail. This evergreen bamboo grows in dense cluster and is highly branched. The young shoots of this species is consumed as pickles and vegetables. Another bamboo species Pareng (*Nep.*), *Himalayacalamus hookerianus* was also recorded along the trekking trail of the forest.

crons. Also used for making threads and baby beds.



### ***Yushania maling* (Gamble) R.B. Majumdar & Karthik**

The forest is dominated by oak species of which 6 species are found in the forest. Four of the six species, *Quercus lamellosa* (13 nos. of *bajranth*), *Lithocarpus pachyphyllus* (8 nos. of *bantey*), *Castanopsis hystrix* (5 nos. of *patley katus*) and *Castanopsis tribuloides* (3 nos. of *musrey katus*) are located within plots. Only 2 species, *Lithocarpus fenestrata* (*arkaulo*) and *Quercus glauca* (*phlant*) are found outside the plot. These oak trees are huge in form creating dense canopy cover especially in the lower part of the forest. The occurrence of such huge and old oak trees provide ecological balance in the forest. They have the ability to sequester carbon dioxide and helps in mitigating the effects of global warming by reducing ground surface temperatures thereby making the forest moist. Being a keystone species, it provides habitat for a wide range of flora and fauna offering shelter and food. Acorns are an important food source for animals and the nuts consumed by humans.

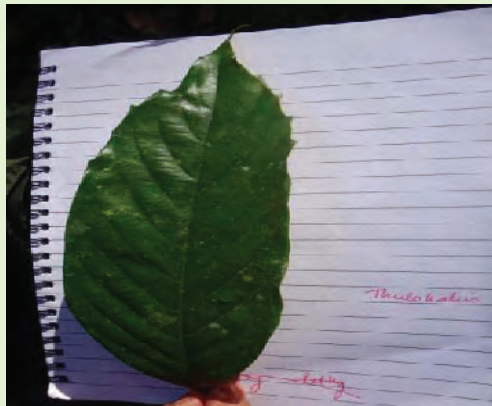


*Quercus lamellosa* Leaf and its seed





*Castanopsis tribuloides* Tree, leaves and seeds



*Lithocarpus pachyphyllus* Seed



Even though the forest is largely dominated by oak species, there are other prominent tree species profusely found in the area. *Elaeocarpus lanceaefolius*, *Zanthoxylum acanthopodium*, *Prunus cerasoides*, *Exbucklandia populnea*, *Macaranga pustulata*, *Mahonia napaulensis*, *Cinnamomum zelynicum*, *Cedrela febrifuga*, *Eurya acuminata*, *Symplocos glomerata* and *S. lucida* are distributed along the forest. Few trees of *Rhododendron arboreum* and *R. hodgsonii* are also found in the forest. Regeneration of *Acer campbellii* and *Magnolia doltsopa* was found to be healthy as compared to the previous study. At lower elevations, branches of trees are swarmed with lichens like *Usnea* sp. and mosses. Buttresses at the base of tree trunks and lianas are predominant sights in the forest as was observed earlier.

The commonly found shrubs/shrublets in the forest are *Ardisia macrocarpa*, *Artemesia* sp., *Azalea* sp., *Cestrum elegans*, *Daphne cannabina*, *Dichroa febrifuga*, *Edgeworthia gardnerii*, *Hydrangea heteromalla*, *Osbeckia stellata*, *Rubus ellipticus*, *R. splendidissimus*, *Smilax rigida*, *Solanum* sp. and *Viburnum erubescence*. Other shrub species recorded in this visit were *Brassiopsis mitis*, *Hypericum uralum*, *Maesa chisia*, *Rubus niveus*, *R. parviflorus*, *R. caesius* and *Vaccinium vacciniaceum*.



*Rubus caesius*



Fruiting of *Rubus calycinus*



*Rubus parviflorus*



*Rubus niveus*





*Rubus splendidissimus*



*Rubus ellipticus*



*Hypericum uralum*



*Cestrum elegans*

In the present survey, 65 herb species were recorded which is comparatively a larger number to the previous study with a recording of only 30 species. The ground flora of the area is widely represented by *Carex* sp., *Cautleya* sp., *Elatostema platyphyllum*, *Eragrostis* sp., *Eupatorium adenophorum*, *Fragaria nubicola*, *Girardiana diversifolia*, *Hedychium gardnerianum*, *Impatiens* sp., *Oxalis corniculata*, *Persicaria capitata*, *Pilea umbrosa*, *Polygonum molle*, etc.

Five *Impatiens* species are available in the RF where one is *unidentified*. Amongst the four *Impatiens* species, *Impatiens uncipectala* and *I. pradhani* were recorded in this visit.

*Impatiens uncipectala*





*Impatiens uncipectala* C.B. Clarke ex Hook.f. (1905:18) was reported by J. D. Hooker in 1905 on the basis of a collection made by C. B. Clarke from Darjeeling hills in the year 1869 and in Sikkim in 1901 (Hooker 1904 – 1906; Gogoi *et al.* 2016). This species is distributed in Nepal as recorded by Hara in 1979. The species epithet “uncipectala” means “with hook-like petals wherein Latin, “uncus” meaning “hook”. This species is rarely distributed in the RF. It is the first record in RBS study amongst the forests surveyed so far.



*Impatiens bicornuta*



*Impatiens sp.*

Synonym *Impatiens pradhanii*



*Impatiens arguta*



*Impatiens stenantha*

Many species of ferns and fern-allies cover the forest floor in clusters while some are found as epiphytes. Some of the commonly occurring ferns and its allies in the reserve forest are *Arthromeris himalayensis*, *A. wallichiana*, *Asplenium ensiforme*, *A. tenuifolium*, *Coniogramme serrulata*, *Cyathea sp.*, *Dennstaedtia scabra*, *Diplazium dilatatum*, *D. himalayense*, *D. stoliczkae*, *Dryopsis apiciflora*, *D. clarkei*, *Dryopteris redactopinnata*, *Gleichenia longissima*, *Lycopodium japonicum*, *Nephrolepis cordifolia*, *Peranema cyatheoides*, *Plagiogyria pycnophylla*, *Pteridium revolutum*, *Pteris biaurita*, *P. wallichiana* and *Selaginella monospora*. Some of the edible ferns available in the forest are *Diplazium dilatatum*, *D. himalayense* and *D. stoliczkae*. While species of *Nephrolepis cordifolia* and *Pteris biaurita* are used as medicines.





*Arthromeris himalayensis*



*Arthromeris wallichiana*



*Asplenium tenuifolium*



*Asplenium ensiforme*



*Coniogramme serrulata*



*Dennstaedtia scabra*(Cup fern)





*Diplazium dilatatum*(Lekh chipley uniu)



*Diplazium himalayense*(Danthey uniu)



*Diplazium stoliczkae*(Lekh kalo ning ro)



*Dryopsis apiciflora*



*Dryopsis clarkei* (Clarke's nest fern)



*Dryopteris redactopinnata*





*Plagiogyria pycnophylla*



*Pteris biaurita*(Tharey uniu)



*Lycopodium japonicum* (Nagbeli)



*Peranema cyatheoides*



*Gleichenia longissima*(Kalamey uniu)



*Cyathea* sp. (Rukh uniu)

The trees also support epiphytes and climbers of various species such as *Piper boehmeriifolium*, *Trichosanthes lepiniana*, *Tetrastigma serrulatum*, *Rhaphidophora decursiva*, *Agapetes serpens*, *Thunbergia* sp., and *Crawfordia speciosa*. These are some of the commonly occurring climbers of the area. A few individual of rarely occurring orchid, *Odontochilus clarkei*, was also recorded in the forest. This species has been recorded in Sikkim, Darjeeling and Arunachal Pradesh.



## DISCUSSION

The forest is dominated by species of oak with maximum number of *Quercus lamellosa* individuals. Apart from this, other prominent species that are seen regenerating are *Magnolia* species, *Acer campbellii*, etc. Not much change in the dominance of the species was observed apart from the naturally occurring oak species. Occurrence of other naturally available trees in the forest seemed healthy with regeneration of various tree species along with other floral species adding to the checklist of the area. Invasive species seemed denser than in the previous study supporting the increase in the number of species. Some prominent species that were recorded in this visit were *Impatiens pradhanii*, *I. arguta*, *I. uncipectala*, etc.

Not much difference in the vegetation was observed in a span of three years. However, there was a recording of some species which were probably missed in the first survey while some were recorded in this visit.

The forest harbours many medicinal plants of high value such as *Abies densa*, *Artemesia*, *Arisaema*, *Astilbe rivularis*, *Eupatorium adenophorum*, *Oxalis corniculata*, *Solanum viarum*, *Rubus ellipticus*, *Rubia manjith*, *Zanthoxylum acanthopodium*, *Piper*, *Rhododendron arboreum*, *Hedychium gardnerianum*, *Nephrolepis cordifolia*, etc. This Reserve Forest also harbours one of the indigenous species of *Acer* viz. *Acer cappadocicum* which was recorded only in one sampling plot (plot no. 3) at an elevation of 2514m asl. *Castanopsis hystrix*, one of the heritage trees with CBH 21.4ft was also recorded in the sampling trial.

**Table 2: Checklist of floral species encountered in Tendong Reserve Forest, South Sikkim**

S. No	Botanical Name	Local Name	Family
	<b>Trees</b>		
1	<i>Acer cappadocicum</i> Gled.	Kapasey	Sapindaceae
2	<i>Acer campbellii</i> Hook.f. & Thomson ex Hiern	Kapasey	Sapindaceae
3	<i>Abies densa</i> Griff.	Gobre Salla	Pinaceae
4	<i>Betula alnoides</i> Buch. Ham. Ex D. Don	Saur	Betulaceae
5	<i>Castanopsis hystrix</i> Hook. f. & Thomson ex A. DC.	Patley Katus	Fagaceae
6	<i>Castanopsis tribuloides</i> (Sm.) A.DC	Musrey Katus	Fagaceae
7	<i>Cedrela febrifuga</i> Blume	Tooni	Meliaceae
8	<i>Cinnamomum verum</i> J.Presl	Sinkoli	Lauraceae
9	<i>Cryptomeria japonica</i> (Thunb. ex L.f.) D.Don	Dhuppi	Cupressaceae
10	<i>Elaeocarpus lanceifolius</i> Roxb.	Bhadrasay	Elaeocarpaceae
11	<i>Engelhardia spicata</i>	Mauwa	Juglandaceae

12	<i>Eurya acuminata</i> DC.	Jhinginey	Pentaphylacaceae
13	<i>Exbucklandia populnea</i> (R.Br. ex Griff.) R.W.Br.	Pipli	Hamamelidaceae
14	<i>Ilex dipyrrena</i> Wall.	Lise	Aquifoliaceae
15	<i>Leucosceptrum cannum</i> Sm.	Ghurpis	Lamiaceae
16	<i>Lithocarpus fenestrata</i> Roxb.	Arkaulo	Fagaceae
17	<i>Lithocarpus pachyphyllus</i> (Kurz) Rehder	Bantey	Fagaceae
18	<i>Lyonia ovalifolia</i> (Wall.) Drude	Angeri	Ericaceae
19	<i>Macaranga pustulata</i> King ex Hook.f.	Malato	Euphorbiaceae
20	<i>Machilus edulis</i> King ex Hook.f.	Pomsi kaulo	Lauraceae
21	<i>Machilus</i> sp.	Lisey kaulo	Lauraceae
22	<i>Macropanax</i> sp.	Chinde	Araliaceae
23	<i>Magnolia doltsopa</i> (Buch. – Ham. ex DC.) Figlar	Rani champ	Magnoliaceae
24	<i>Mahonia napaulensis</i> DC.	Mandre chutro	Berberidaceae
25	<i>Michelia velutina</i> DC.	Phusrey champ	Magnoliaceae
26	<i>Nyssa sessiliflora</i> Hook. f. & Thomson ex Benth	Lek chilauney	Cornaceae
27	<i>Prunus cerasoides</i> Buch.-Ham. ex D.Don	Payun	Rosaceae
28	<i>Prunus bracteopadus</i> Koehne	Arupatey	Rosaceae
29	<i>Pterospermum acerifolium</i> (L.) Willd.	Hattipaila	Malvaceae
30	<i>Quercus glauca</i> Thunb.	Phlant	Fagaceae
31	<i>Quercus lamellosa</i> Sm.	Bajranth	Fagaceae
32	<i>Rhododendron arboreum</i> Sm.	Lali Gurans	Ericaceae
33	<i>Rhododendron hodgsonii</i> Hook. f.	Korlinga	Ericaceae
34	<i>Rhus succedanea</i> Linn	Rani bhalayo	Anacardiaceae
35	<i>Symplocos glomerata</i> King ex C.B. Clarke	Kholmey	Symplocaceae
36	<i>Symplocos lucida</i> (Thunb.) Siebold & Zucc.	Kharaney	Symplocaceae
37	<i>Tetradium fraxinifolium</i> (Hook.f.) T.G. Hartley	Khanakpa	Rutaceae
38	<i>Tsuga dumosa</i> (D.Don) Eichler	Thengra Salla	Pinaceae
39	<i>Zanthoxylum acanthopodium</i> DC.	Boke timboor	Rutaceae
	<b>Shrubs</b>		
1	<i>Ardisia macrocarpa</i> Wall.	Damai phal	Primulaceae
2	<i>Azeleasp.</i>		Ericaceae
3	<i>Brassiopsis mitis</i> CB Clarke	Chuletro	Araliaceae
4	<i>Cestrum elegans</i> (Brongn. Ex Neumann) Schldtl.		Solanaceae
5	<i>Daphne cannabina</i> Lour. ex Wall.	Kalo argayle	Thymelaeaceae
6	<i>Dichroa febrifuga</i> Lour.	Basak	Hydrangaceae
7	<i>Edgeworthia gardneri</i> (Wall.) Meisn.	Loktee	Thymelaeaceae
8	<i>Hydrangea heteromalla</i> D.Don	Bhogote	Hydrangeaceae
9	<i>Hypericum uralum</i> Buch.-Ham. ex D.Don	Yurilo	Hypericaceae
10	<i>Maesa chisia</i> Buch.-Ham. ex D.Don	Bilaunay	Primulaceae
11	<i>Neillia rubiflora</i> DC	Kirkirey jhar	Rosaceae
12	<i>Osbeckia stellata</i> Buch.-Ham. Ex Ker Gawl.	Chulesi	Melastomataceae
13	<i>Pyracanthasp.</i>		Rosaceae
14	<i>Rubus ellipticus</i> Smith	Ainselu	Rosaceae
15	<i>Rubus niveus</i> Thunb	Ainselu	Rosaceae



16	<i>Rubus parviflorus</i> Nutt.	Ainselu	Rosaceae
17	<i>Rubus splendidissimus</i> H. Hara	Phusre ainselu	Rosaceae
18	<i>Rubuscaesius</i> Linneus	Ainselu	Rosaceae
19	<i>Smilax rigida</i> Wallich ex Kunth		Smilacaceae
20	<i>Solanum viarum</i> Dunal	Jungleebey	Solanaceae
21	<i>Vaccinium vacciniaceum</i> (Roxb.) Sleumer	Tibetan Blueberry	Ericaceae
22	<i>Viburnum erubescens</i> Wall.	Asare	Caprifoliaceae
	<b>Herbs</b>		
1	<i>Aconogonum molle</i> D. Don	Thotney	Polygonaceae
2	<i>Ageratina adenophora</i> (Spreng.) R.M. King & H. Rob.	Kalijhar	Asteraceae
3	<i>Ainsliaea aptera</i> DC	Tito Butee	Asteraceae
4	<i>Anaphalis contorta</i> (D. Don.) Hook. f.	BukiPhool	Asteraceae
5	<i>Anaphalis triplinervis</i> (Sims) C. B. Clarke	BukiPhool	Asteraceae
6	<i>Arisaema concinnum</i> Schott	Mitinee bako	Araceae
7	<i>Arisaema speciosum</i> (Wall.) Mart	Sapko Makai	Araceae
8	<i>Arisaema tortuosum</i> (Wall.) Schott.	Lauro/Banko/Sap ko phool	Araceae
9	<i>Artemesia vulgaris</i> Linn.	Titepati	Asteraceae
10	<i>Astilbe rivularis</i> Buch.-Ham. ex D. Don	Buro Okhati	Saxifragaceae
11	<i>Begonia josephi</i> A. DC.	Magar kajey	Begoniaceae
12	<i>Begonia tessaricarpa</i> C. B. Clarke	Magar kajey	Begoniaceae
13	<i>Bidens pilosa</i> Linn.	Kuro	Asteraceae
14	<i>Calceolaria bilatata</i>	Lady's purse	Calcolariaceae
15	<i>Campanula pallida</i> Wall.	Gaanobuti/Nepali bikh	Campanulaceae
16	<i>Campylandra aurantica</i> Baker	Junglee nakima	Liliaceae
17	<i>Carex</i> sp.	Harkatto	Cariceae
18	<i>Cautleya</i> sp.		Zingiberaceae
19	<i>Centella asiatica</i> (L.) Urb.	Golpatta	Apiaceae
20	<i>Clinopodium umbrosum</i> (M. Bieb.) Kuntze		Lamiaceae
21	<i>Commelina benghalensis</i> Linn.	Kaney jhar	Commelinaceae
22	<i>Craniotome furcata</i> (Link) Kuntze	Multicolored Catmint, Batule silam	Lamiaceae
23	<i>Cyanotis vaga</i> (Lour.) Schult. & Schult. f.	Kanay jahr	Commelinaceae
24	<i>Digitaria</i> sp.	Banso	Poaceae
25	<i>Drymaria cordata</i> (L.) Wild. Ex Roem. & Schult.	Abhijalo	Caryophyllaceae
26	<i>Elatostema platyphyllum</i> Wedd.	Gagleto	Urticaceae
27	<i>Eragrostis</i> sp.	Chitre banso	Poaceae
28	<i>Eragrostis</i> sp.	Banso	Poaceae
29	<i>Fragaria nubicola</i> (Lindl. ex Hook. f.) Lacaita	Bhui Aiselo	Rosaceae
30	<i>Geranium wallichianum</i> D. Don ex Sweet		Geraniaceae
31	<i>Girardinia diversifolia</i> (Link) Friis	Bhangrey Sisnu	Urticaceae
32	<i>Gonatanthus pumilus</i> D. Don.	Manay	Araceae

33	<i>Gynura cusimbua</i> (D.Don) S.Moore		Asteraceae
34	<i>Hedychium gardnerianum</i> Sheppard ex Ker Gawl.	Saro	Zingiberaceae
35	<i>Hedychium spicatum</i> Sm.	Gai sara	Zingiberaceae
36	<i>Hemiphragma heterophyllum</i> Wall.	Lalgeri	Plantaginaceae
37	<i>Henckelia urticifolia</i> (Buch.-Ham. ex D.Don) A.Dietr		Gesneriaceae
38	<i>Houttuynia cordata</i> Thunb.	Padey jhar, Gandhey	Saururaceae
39	<i>Hydrocotyle javanica</i> Thunb.	Dhungri jhar	Umbelliferae
40	<i>Impatiens bicornuta</i> Wall.	Raja bubu	Balsaminaceae
41	<i>Impatiens arguta</i> Hook.f. & Thomson	Mujuro	Balsaminaceae
42	<i>Impatiens</i> sp.	Mujuro	Balsaminaceae
43	<i>Impatiens stenantha</i> Hook. f.	Mujuro	Balsaminaceae
44	<i>Impatiens uncipectala</i> C.B.Clarke ex Hook.f.		Balsaminaceae
45	<i>Lecanthus peduncularis</i> (Royle) Weddell	Gagleto	Urticaceae
46	<i>Leucas lanata</i> Benth.		Lamiaceae
47	<i>Lobelia</i> sp.		Campanulaceae
48	<i>Lysimachia debilis</i> Wall.	Weak Loosestrife	Primulaceae
49	<i>Oxalis corniculata</i> L.	Amilo Jhar	Oxalidaceae
50	<i>Peperomia tetraphylla</i> (G.Forst.) Hook. & A.		Piperaceae
51	<i>Persicaria capitata</i> (Buch.-Ham. ex D.Don) H.Gross	Ratnaulo	Polygonaceae
52	<i>Pilea grandifolia</i> Blume	Chiplej jhar	Urticaceae
53	<i>Pilea stricta</i> (Buchanan-Hamilton ex D. Don) Weddell	Chiple jhar	Urticaceae
54	<i>Pilea umbrosa</i> Blume	Chiplej Jhar	Urticaceae
55	<i>Polygonum runcinatum</i> Buch.-Ham. ex D. Don	Ratnaulo	Polygonaceae
56	<i>Rubia manjith</i> Roxb. ex Fleming	Majito	Rubiaceae
57	<i>Rubus calycinus</i> Wall. ex D.Don	Bhalu Aisilo	Rosaceae
58	<i>Sarcopyramis napalensis</i> Wall.		Melastomataceae
59	<i>Strobilanthes</i> sp.	Kibughas	Acanthaceae
60	<i>Swertia bimaculata</i> (Siebold & Zucc.) Hook.f. & Thomson ex C.B. Clarke	Bhaley chiraito	Gentianaceae
61	<i>Thalictrum</i> sp.		Ranunculaceae
62	<i>Trifolium repens</i> L.	Dhungri jhar/Teen patey	Leguminosae
63	<i>Urtica dioica</i> L.	Patley sisnu	Urticaceae
64	<i>Urtica parviflora</i> Roxb.	Gharia sisnu	Urticaceae
65	<i>Viola</i> sp.		Violaceae
	<b>Epiphytes</b>		
1	<i>Agapetes serpens</i> (Wight) Sleumer	Khorsane	Ericaceae
2	<i>Bulbophyllum</i> sp.	Sunakhari	Orchidaceae
3	<i>Coelogyne cristata</i> Lindl.	Sunakhari	Orchidaceae
4	<i>Dendrobium</i> sp.	Sunakhari	Orchidaceae
5	<i>Eria spicata</i> (D. Don) Hand.-Mazz	Sunakhari	Orchidaceae

6	<i>Odontochilus clarkei</i> Hook. f.		Orchidaceae
7	<i>Pleione praecox</i> (Sm.) D. Don	Sunakhari	Orchidaceae
8	<i>Rhaphidophora decursiva</i> (Roxb.) Schott	Kanchirna	Araceae
9	<i>Stephania</i> sp.	Tamarki	Menispermaceae
10	<i>Tetrastigma serrulatum</i> (Roxb.) Planch.	Charcharey	Vitaceae
11	<i>Usnea</i> sp.		Parmeliaceae
	<b>Climbers</b>		
1	<i>Cissus elongata</i> Roxb.	Charcharey lahara	Vitaceae
2	<i>Clematis</i> sp.	Pinasay lahara	Ranunculaceae
3	<i>Crawfordia speciosa</i> C.B. Clarke	Blue bell flower	Gentianaceae
4	<i>Dioscorea bulbifera</i> L.	Gitta	Dioscoraceae
5	<i>Herpetospermum pedunculatum</i> (Seringe.) C.B. Clarke	Ban karela	Cucurbitaceae
6	<i>Mucuna macrocarpa</i> Wall.	Baldengra	Leguminaceae
7	<i>Piper boehmeriifolium</i> (Miq.) Wall. ex C. DC.	Jungle Paan	Piperaceae
8	<i>Rubia cordifolia</i> Linn.	Majito	Rubiaceae
9	<i>Smilax zeylanica</i> L.	Kukur dainey	Smilacaceae
10	<i>Thunbergia coccinea</i> Wall.	Singaarne Lahara	Acanthaceae
11	<i>Thunbergia lutea</i> T. Anderson	Sikkim Clock Vine	Acanthaceae
12	<i>Trichosanthes lepiniana</i> (Naudin) Cogn.	Indreni	Cucurbitaceae
	<b>Bamboo</b>		
1	<i>Yushania maling</i> (Gamble) R.B. Majumdar & Karthik.	Hangay malingo	Poaceae
2	<i>Himalayacalamus hookerianus</i> (Munro) Stapleton	Pareng	Poaceae
	<b>Ferns and Fern-allies</b>		
1	<i>Arthromeris himalayensis</i> (Hook.) Ching		Polypodiaceae
2	<i>Arthromeris wallichiana</i> (Spreng.) Ching		Polypodiaceae
3	<i>Asplenium ensiforme</i> Wall. Ex Hook. & Grev.		Aspleniaceae
4	<i>Asplenium tenuifolium</i> D. Don		Aspleniaceae
5	<i>Coniogramme serrulata</i> (Blume) Fee		Pteridaceae
6	<i>Cyathea chinensis</i> Copel.	Ruhk uniu, Tree Fern	Cyatheaceae
7	<i>Dennstaedtia scabra</i> (Wall. Ex Hook) T. Moore	Cup fern	Dennstaedtiaceae
8	<i>Diplazium dilatatum</i> Blume	Lekh chipley ningro	Woodsiaceae
9	<i>Diplazium himalayense</i> Panigrahi	Danthey ningro	Athyriaceae
10	<i>Diplazium</i> sp.	Ningro	Woodsiaceae
11	<i>Diplazium stoliczkae</i> Beddome	Lekh kalo ningro	Woodsiaceae
12	<i>Dryopsis apiciflora</i> (Wall. Ex Mett) Holttum & Edwards		Dryopteridaceae
13	<i>Dryopsis clarkei</i> (Baker) Holttum & P.J. Edwards	Clarke's nest fern	Dryopteridaceae
14	<i>Dryopteris redactopinnata</i> S.K. Basu & Panigrahi	Unew	Dryopteridaceae
15	<i>Gleichenia longissima</i> Blume	Kalamey uniu	Gleicheniaceae



16	<i>Lycopodium japonicum</i> Thunb.	Nagbelli	Lycopodiaceae
17	<i>Nephrolepis cordifolia</i> (L.) C. Presl	Pani Amala	Nephrolepidaceae
18	<i>Peranema cyatheoides</i> D. Don		Dryopteridaceae
19	<i>Plagiogyria pycnophylla</i> (Kunze.) Mett.		Plagiogyriaceae
20	<i>Pteridium revolutum</i> (Blume) Nakai	Sottarey uniu, Pere ningro	Dennstaedtiaceae
21	<i>Pteris biaurita</i> L.	Thare uniu	Pteridaceae
22	<i>Pteris wallichiana</i> J. Agardh	Chatey Uniu	Pteridaceae
23	<i>Selaginella monospora</i> Spring	Sindure/ Jhew	Selaginellaceae

## Monitoring of Sang – Tinjurey sampling path, Fambong Lho Wildlife sanctuary, East Sikkim

*Nimesh Chamling & Dorjee Chewang Bhutia*

The present monitoring under rapid biodiversity survey (RBS) was conducted at Fambong Lho Wildlife Sanctuary (FWS). It is located at a latitude 27°18'10"N to 27°22'50"N and longitude 88°27'15"E to 88°35'25"E. The total area of the sanctuary is 51.76 sq km and the altitude ranges between 1200 to 2624 m asl (Tinchuli, synonym: Tinjurey). The sanctuary is rich in biodiversity with lush green vegetation and mainly dominated by the oak species (*Quercus* sp., *Castanopsis* spp). The canopies of oak trees provideshelter to animals like red panda, squirrels, and birds and acorns from oak trees are eaten by these mammalsbecause it is rich in nutrition. To study the variation and changes in the vegetation, monitoring was conducted in the same sampling plots after a gap of three years. The vegetation was healthy and there was a good sign of natural regeneration for some of the species.



**View of Fambong Lho Sanctuary**

The main vegetation of the Sanctuary is mainly dominated by *Castanopsis hystrix*, *Castanopsis tribuloides*, *Quercus lamellose*, *Michelia doltsopa*, *Symplocos glomerata*, *Symplocos lucida*, *Engelhardtia spicata*, *Erythrina arborescens*, *Macaranga pustulata*, *Acer campbelli*, *Prunus nepalensis*, *Leucosceptrum cannum*, *Gynocardia odorata*, *Cryptomeria japonica*, etc. The common types of shrubs found are *Viburnum erubescence*, *Rubus*

*paniculatus*, *Edgeworthia gardenerii*, *Daphne cannabina*, *Ardisia macrocarpa*, *Rubus ellipticus*, etc. During the survey we came across some bamboo species viz., *Arundinaria maling*, *Arundinaria hookerian*, *Sinarundinaria intermedia* and *Schizostachyum capitatum*. Among all these bamboo species encountered in our survey *Arundinaria maling* and *Arundinaria hookerian* were more dominant and abundant. The species of rhododendron, wild orchids, mosses, wild mushrooms and ferns were also recorded during monitoring.

The sanctuary is home to some of the mammals like Red panda, Leopard cat, Chinese pangolin, Himalayan black bear, Flying squirrel, Jackal, Barking deer, Goral, Wild pig, Yellow-throated marten, etc. But there is lot of complaints from villagers regarding the damage done to their crops and livestock by Himalayan black bear. They informed us that the population of this mammal has gone up and it has become a real concern for them. So they want a proper management plan for this mammal. The sanctuary is also rich in avifaunal species like Kalij pheasant, Satyr tragopan, Green pigeon, Black eagle, Common cuckoo, Wedge-tailed green pigeon, Himalayan tree pie, etc. It is also a good destination for birders, so they should definitely come over this place for bird watching.

The current monitoring was conducted from the Sang area following the same route from the earlier survey path. The altitude of the surveyed path ranged from ca. 1600 m asl to 2350 m asl lying between 27°16' – 27°17'N latitude and 88°29' – 88°31'E longitude on the north-eastern part of the sanctuary. Much of the forest consists of moderately dense to dense vegetation. The broad vegetation of the area is dominated by wet temperate forest type. The important tree species of the forest are *Prunus nepalensis*, *Castanopsis hystrix*, *Quercus lamellosa*, *Lithocarpus pachyphyllus*, *Castanopsis tribuloides* and *Castanopsis hystrix*. These species were common along the sampling path from midway till top of the sanctuary. But the natural regenerations of the oak species viz., *Castanopsis hystrix*, *Castanopsis hystrix*, *Castanopsis tribuloides* and *Quercus lamellosa* were neglected or nil. So it is a concern for the ecosystem. These oak trees were mainly old, over-matured and decayed. So for the proper management of the ecosystem such trees should be removed from the stands. Once these trees are removed from the forest it gives space for light to enter the forest floor and which helps in natural regenerations of these species.

The presence of oak species signifies a healthy ecosystem as they are the critical components of a healthy terrestrial ecosystem and which helps to provide habitat to the forest-dwelling mammal such as red panda, etc. Its root system helps to stabilize the soil and prevent it from erosion. The acorns are highly nutritious with rich in potassium, iron, vitamins A & E, proteins, fats, etc. and it is a source of food for the wild animals. It is eaten by squirrels, deer, rodents, etc.





**Lake inside the Fambong Lho Wildlife Sanctuary**

During the revisit we notice most of the forest area were mainly covered by *Symplocos glomerata* and *Symplocos lucida* of smaller bole size. The natural regeneration of these species was vigorous and even the survival rate was good in both seedling and sapling stage. While the natural regeneration was nil for oak species, which is a serious concern which we need to bother for maintaining the healthy ecosystem of the forest in near future. The oak species are categorized as ‘keystone species’ because it provides food and shelter to various plants and animals in an ecosystems. Most of the forest floor was covered by ferns species such as *Lycopodium clavatum*, *Silagenella sp*, *Asplenium ensiforme*, *Asplenium laciniatum*, *Coniogramme intermedia*, etc. While the dominant herb present in the area were *Viola serpens*, *Pilea umbrosa*, *Aconogonum molle*, *Gerardiana diversifolia*, *Carex sp.*, *Urtica dioica*, etc.

The sanctuary is free from anthropogenic disturbances. After imposing ban on grazing the villagers are more conscious and they are not letting their domestic animals to enter the sanctuary for grazing. In the past there was an incidence of forest fire, which had devastated a large chunk of forest area of the sanctuary, which is now mainly covered with *Urtica dioica*, *Rumex nepalensis*, etc. showing the signs of regeneration. The people of the nearby villages have become aware about the impact of forest fire in the forest ecosystem and they have taken initiatives to tackle it in future if similar incidence occurs. Now there are good sign of natural regeneration of *Symplocos glomerata* and *Symplocos lucida*, even there are some sign of natural regeneration of *Acer caudatum*, *Eurya acuminata*, *Leucosceptrum cannum*, and *Macaranga pustulata* in the affected area.









### Forest composition along Sang – Tinjurey sampling path, Fambong Lho Wildlife Sanctuary, East Sikkim

During the revisit, we came across the rain fed lake in our sampling path in the sanctuary at an altitude of *ca.*>2100 m asl. It is the water source for the wildlife inside the sanctuary. Management plan is required to preserve this lake for the long term benefit of the sanctuary. The lake is surrounded by *Symplocos glomerata*, *Symplocos lucida* along the periphery of the lake, while the species such as *Acorus calamus*, *Digitaria* sp, *Gerardiana diversifolia*, *Osbeckia stellata*, etc occupied the forest floor.

Somewhere in midway at an altitude *ca.* 2000 m asl we observed *Arundinaria hookeriana* a bamboo species in growing together good number with wild banana (*Musa* sp). While the ground vegetation was mainly covered by *Gerardiana diversifolia*, *Impatiens* sp, *Carex* sp, etc. There was a fewer natural regeneration of *Symplocos glomerata* and *Symplocos lucida* and *Cedrela febrifuga*. During the revisit we encounter *Dendrobium chrysanthum* wild orchid species in full blossom.

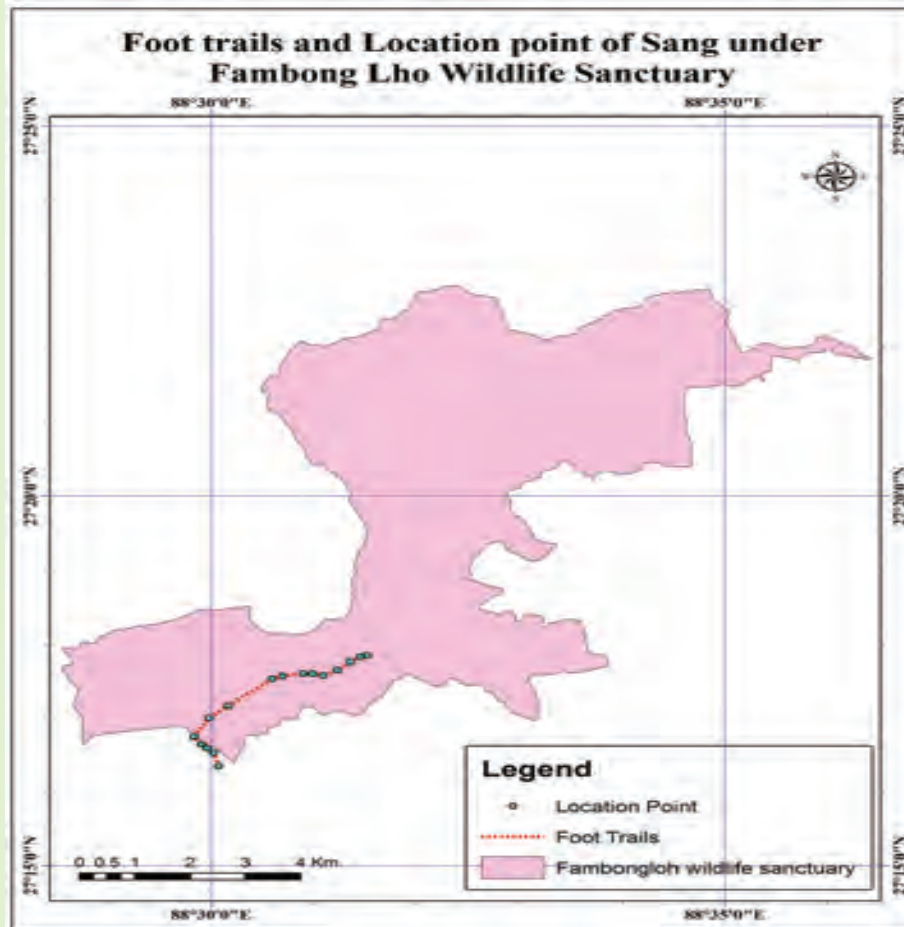


### Field Activities of Survey team during the monitoring the sampling plot in Fambong Lho Sanctuary

#### Study Area

The current monitoring was carried out along the Sang-Tinjurey sampling path under Fambong Lho Wildlife Sanctuary, East Sikkim in the month of September, 2019. The altitude of the surveyed path ranged from 1686m-2258m (msl). The forest lies between 27°16'20.7"-27°17'50.62" Latitude(N) and 88°30'04.4"- 88°31'31.4" Longitude (E). The slope angle of the surveyed area ranged from 15° to 50° and the aspect facing towards E, W, N, SW and NW. The average depth of the humus is 4 cm and the Canopy Cover is between 10%-95%.





**Figure 1. Map showing the Sang-Tinjurey sampling path under Fambong Lho Wildlife Sanctuary, East Sikkim**

### **Finding and Discussions**

During the monitoring survey in 16 plots along Sang-Tinjurey sampling path, 39 tree species belonging to 32 genera and 21 families were recorded. Similarly, 8 species of shrubs (7 genera and 5 families) and 21 herb species (19 genera, 11 families) were witnessed. In addition, 28 ferns & fern-allies species (23 genera, 13 families) and 16 epiphytes/climbers (15 genera, 11 families and 3 unidentified) were recorded. Total of 3 bamboo species (consisting 3 species, 1 family) was recorded. While a total of 8 faunal species with (8 genus, 8 families) and a total of 18 bird species belonging to (18 genus, 14 families) were recorded during the monitoring visit. Family wise analysis revealed that Fagaceae and Ericaceae to be the most dominant tree family with 4 species each. In Shrub, Rosaceae & Thymeliaceae was the dominant family with 2 species each. Urticaceae was the most dominant family with 6 species. While in fern & fern-allies Woodaceae was the dominant family followed by Selaginellaceae and Aspleniaceae with 3 species each.

**Site characteristics of the sampling plots along Sang – Tinjurey sampling path, Fambong  
Lho Wildlife Sanctuary, East Sikkim**

Site Code	Forest type	Altitude (m)	Aspect	Slope (0)	Points	GPS	
						Lat (N)	Long (E)
ST1	Temperate Broadleaved Forest	1686	E	30	1	27°16'20.7"	88°30'04.4"
ST2	Temperate Broadleaved Forest	1762	E	20	1	27°16'31.7"	88°30'01.4"
ST3	Temperate Broadleaved Forest	1816	E	15	1	27°16'35.7"	88°29'57.3"
ST4	Temperate Broadleaved Forest	1895	E	35	1	27°16'44.8"	88°29'54.10"
ST5	Temperate Broadleaved Forest	1939	E	20	1	27°16'44.7"	88°29'49.7"
ST6	Temperate Broadleaved Forest	1995	E	35	1	27°17'00.0"	88°29'58.7"
ST7	Temperate Broadleaved Forest	2028	SE	40	1	27°17'10.1"	88°30'10.0"
ST8	Temperate Broadleaved Forest	2051	SE	25	1	27°17'31.7"	88°30'35.6"
ST9	Temperate Broadleaved Forest	2105	N	15	1	27°17'39.92"	88°30'41.73"
ST10	Temperate Broadleaved Forest	2194	W	15	1	27°16'36.0"	88°30'53.84"
ST11	Temperate Broadleaved Forest	2245	W	20	1	27°17'35.90"	88°30'58.97"
ST12	Temperate Broadleaved Forest	2242	E	20	1	27°17'34.7"	88°30'15.20"
ST13	Temperate Broadleaved Forest	2228	NW	35	1	27°17'38.95"	88°31'13.88"
ST14	Temperate Broadleaved Forest	2253	NW	30	1	27°17'45.63"	88°31'21.45"
ST15	Temperate Broadleaved Forest	2213	SW	35	1	27°17'49.35"	88°31'27.42"
ST16	Temperate Broadleaved Forest	2258	N	40	1	27°17'50.62"	88°31'31.4"

**Checklist of Floral species along Sang – Tinjurey sampling path, Fambong Lho Wildlife  
Sanctuary, East Sikkim**

S.No	Species	Local name	Family	Altitudinal Range (m)
<b>Trees</b>				
1	<i>Acer caudatum</i> Wallich.	Kapasey	Aceraceae	1700-4000
2	<i>Actinodaphne sikkimensis</i> Meissn.	Phurkey sissi	Lauraceae	
3	<i>Betula alnoides</i> Wall. ex Diels	Saur	Betulaceae	700-2100
4	<i>Castanopsis hystrix</i> Hook. & Thomson ex. A. DC.	Patley katush	Fagaceae	Up to 1600
5	<i>Castanopsis tribuloides</i> (Smith) A. DC.	Musrey katush	Fagaceae	Up to 1300
6	<i>Cedrela febrifuga</i> Blume.	Tuni	Meliaceae	
7	<i>Cinnamomum impressinervium</i> Meisn.	Sinkoli	Lauraceae	Up to 2000
8	<i>Cryptomeria japonica</i> (Thunberg ex. Linn. F.) D. Don	Dhuppi	Taxodiaceae	1100-2500
9	<i>Elaeocarpus lanceaefolius</i> Roxburgh.	Bhadrasey	Elaeocarpaceae	Up to

				2400
10	<i>Erythrina arborescens</i> Roxb.	Phaledo	Fabaceae	Up to 1800
11	<i>Eurya acuminata</i> DC.	Jhingni	Theaceae	700-3000
12	<i>Exbucklandia populnea</i> R. Br. Ex Griff	Piplee	Hamamelidaceae	Up to 1200
13	<i>Glochidion acuminatum</i> Muell.	Latikaath	Euphorbiaceae	1000-1400
14	<i>Gynocardia odorata</i> Roxburgh	Bandre/Gante	Flacourtiaceae	800-1000
15	<i>Leucosceptum cannum</i> Smith	Ghurpis	Lamiaceae	1400-1600
16	<i>Lithocarpus pachyphyllus</i> Roxb.	Arkaulo	Fagaceae	1000-2800
17	<i>Litsea kingii</i> Hook.	Siltimmur	Lauraceae	Up to 1000
18	<i>Macaranga pustulata</i> King.	Malato	Euphorbiaceae	1100-2100
19	<i>Machilus gammieana</i> King ex. Hook. f.	Chipli kawlo	Lauraceae	
20	<i>Machilus odoratissima</i> Wall. ex. Nees	Ghew kawlo/Lali Kawlo	Lauraceae	850-1200
21	<i>Michelia cathcartii</i> Hook. f. Thomson	Tite chanp	Magnoliaceae	Up to 2200
22	<i>Michelia doltsopa</i> Buch.- Ham. ex Dc.	Rani chanp	Magnoliaceae	1400-2600
23	<i>Myrica esculenta</i> Buch. Ham.	Kafal	Myricaceae	300-2500
24	<i>Myrsine semiserrata</i> Wall.	Phalame	Myrsinaceae	500-2700
25	<i>Nyssa sessiliflora</i> Hook. f. & Thomson ex Benth	Lek chilauney	Cornaceae	
26	<i>Ostedes paniculatus</i> Blume.	Bepari	Euphorbiaceae	
27	<i>Toona ciliata</i> Roemer	Tuni	Meliaceae	400-2800
28	<i>Pieris ovalifolia</i> (Wall) D. Don.	Angeri	Ericaceae	800-1200
29	<i>Prunus nepalensis</i> (Ser) Stendel	Arupatey	Rosaceae	1800-2500
30	<i>Pyralaria edulis</i> (Wallich) A.	Amphi	Santalaceae	700-2700
31	<i>Quercus lamellosa</i> Smith.	Buk/Bajranth	Fagaceae	1100-2600
32	<i>Rhododendron arboreum</i> ssp. <i>arboreum</i> (CB Clarke) Ridley.	Lali gurans	Ericaceae	1500–3800
33	<i>Rhododendron grande</i> Wight.	Patle korlinga	Ericaceae	1600–2900
34	<i>Rhododendron griffithianum</i> Wight.	Seto chimal	Ericaceae	2100–2800
35	<i>Rhus succedanea</i> Linn.var. <i>acuminata</i>	Rani bhalayo	Anacardiaceae	1200-2400
36	<i>Schima wallichii</i> (DC) Korth.	Chilaune	Theaceae	800-2700
37	<i>Spondias axillaris</i> Roxb.	Lapsi	Anacardiaceae	Up to 1200
38	<i>Symplocos glomerata</i> King, ex. C.B. Clarke	Kholme	Symplocaceae	1200-2700
39	<i>Symplocos theifolia</i> D. Don	Kharane	Symplocaceae	1200-2700
<b>Shrub</b>				
1	<i>Ardisia macrocarpa</i> Wall.	Damai phal	Myrsinaceae	1500-2400
2	<i>Daphne cannabina</i> Wall.	Kalo algeri/Kagate	Thymeleaceae	700-2800



3	<i>Dichroa febrifuga</i> Lour	Basak	Hydrangeaceae	Up to 2300
4	<i>Edgeworthia gardenerii</i> Meissn.	Algeri/Lokti	Thymeliaceae	1000-2500
5	<i>Maesa chisia</i> Don	Bilauney	Myrsinaceae	600-2200
6	<i>Rubus ellipticus</i> Smith.	Aiselu	Rosaceae	900-1300
7	<i>Rubus paniculatus</i> (Smith) Rees.	Kalo Aiselu	Rosaceae	Up to 2400
8	<i>Viburnum erubescence</i> Wall. ex DC	Asarey	Caprifoliaceae	1800-2200
<b>Herb</b>				
1	<i>Aconogonum molle</i> (D. Don) H. Hara	Thotne	Polygonaceae	1300-3500
2	<i>Arisaema intermedium</i> Blume	Larua/Banko	Araceae	Up to 2000
3	<i>Boehmeria</i> sp.	Kamley	Urticaceae	
4	<i>Carex</i> sp.	Harkatto	Cyperaceae	
5	<i>Digitaria sanguinalis</i> (Linn.) Scopoli.	Banso	Poaceae	Up to 1200
6	<i>Elatostema platyphyllum</i> Weddell.	Gagleto	Urticaceae	700-1900
7	<i>Eragrostis cilianensis</i> (All.) Lut. ex Janchen	Banso	Poaceae	Up to 1000
8	<i>Eupatorium adenophorum</i> Spreng.	Kali jhar	Compositae	800-2000
9	<i>Gerardiana diversifolia</i> (Link) Friis	Bhangre sisnu	Urticaceae	1200-3000
10	<i>Gleichenia gigantean</i> Wall. ex Hook	Kalamey	Gleicheniaceae	Up to 1000
11	<i>Impatiens stenantha</i> Hook. f.		Balsaminaceae	2400-3000
12	<i>Pilea stricta</i> (Buchanan-Hamilton ex D. Don) Weddell	Chiple	Urticaceae	Up to 1700
13	<i>Pilea umbrosa</i> Blume.	Chiple	Urticaceae	1200-2500
14	<i>Pouzolzia sanguine</i> (Blume) Merrill	Chiple	Urticaceae	Up to 1100
15	<i>Rumex nepalensis</i> Spreng.	Halhalley	Polygonaceae	1000-4300
16	<i>Smilax rigida</i> Wall. ex Kunth	Madaney kara / Kirneyghans	Smilacaceae	Up to 1200
17	<i>Strobilanthes</i> sp.	Kibu ghans	Acanthaceae	
18	<i>Urtica parviflora</i> Roxburgh	Gharia sisnu	Urticaceae	450-3500
19	<i>Urtica dioica</i> Linn.	Patley sisnu	Urticaceae	500-3000
20	<i>Villebrunea frutescens</i> (Thunb.) Blume	Chiple	Urticaceae	1100-1600
21	<i>Viola sikkimensis</i> W. Becker		Violaceae	Up to 2000
<b>Ferns &amp; Fern allies</b>				
				1000-2000
1	<i>Arachniodes henryi</i> (Christ) Ching.	Uniu	Dryopteridaceae	
2	<i>Asplenium ensiforme</i> wall. Ex Hook. & Grev.	Uniu	Aspleniaceae	1000-2400
3	<i>Asplenium laciniatum</i> D. Don.	Uniu	Aspleniaceae	1100-2000
4	<i>Asplenium phyllitidis</i> D. Don	Uniu	Aspleniaceae	
				1600-2300
5	<i>Athyrium pectinatum</i> (Wall. Ex Mett.) T. Moore	Uniu	Woodaceae	
6	<i>Coniogramme intermedia</i> Heiron.	Uniu	Pteridaceae	1600-3500

7	<i>Davallodes membranulosa</i> (Hook.) Copel.	Uniu	Davalliaceae	
				1300-2600
8	<i>Dennstaedtia scabra</i> (Wall.ex Hook.) T.Moore	Uniu	Dennstaedtiaceae	
				1500-2600
9	<i>Deparia petersenii</i> (Kunze) M. Kato		Woodaceae	
10	<i>Diplazium dilatatum</i> Blume	Lek Chipley Ningro	Woodsiaceae	1600-3800
11	<i>Diplazium medogense</i> (Ching & S.K. Wu) Fraser-Jenk.	Uniu	Woodsiaceae	1500-2500
12	<i>Diplazium stoliczkae</i> Beddome	Lek kalo ningro	Woodsiaceae	
				2200-2700
13	<i>Goniophebiium argutum</i> (Wall.ex Hook.)J.Smith		Polypodiaceae	
14	<i>Huperzia subulifolia</i> (Wall.ex Hook. & Grev.)	Uniu	Lycopodiaceae	1200-2400
15	<i>Lepisorus scolopendrium</i> (Ham. Ex D.Don.) Mehra & Bir		Polypodiaceae	1600-3200
16	<i>Lycopodium japonicum</i> Thunb	Nagbelli	Lycopodiaceae	1200-2400
17	<i>Monachosoram henryi</i> Christ.	Uniu	Monachosoraceae	Up to 2400
18	<i>Nephrolepis cordifolia</i> (Linn.) C. Presl.	Pani amala	Davalliaceae	
				1700-3000
19	<i>Oleandra wallichii</i> (Hook.) C.Presl		Oleandraceae	
				2500-3500
20	<i>Pichisermollodes ebenipes</i> (Hook) Fras.-Jenk.		Plagiogyriaceae	
21	<i>Plagiogyria pycnophylla</i> (Kunze.) Mett.	Uniu	Plagiogyriaceae	1800-3400
22	<i>Polypodiodes microrhizoma</i> (C.B.Clark ex Bak.) Ching			1700-3200
23	<i>Selaginella biformis</i> A. Br. ex Kuhn		Selaginellaceae	1600-2600
24	<i>Selaginella chrysocaulos</i> (Hook. & Grev.) Spring.		Selaginellaceae	
25	<i>Selaginella monospora</i> Spring.		Selaginellaceae	
				1800-3600
26	<i>Tomophyllum donianum</i> (D.Don) Fraser-Jenk.	Uniu	Grammitidaceae	
27	<i>Vittaria flexuosa</i> Fee.	Uniu		
				1000-2000
28	<i>Arachniodes henryi</i> (Christ) Ching.	Uniu	Dryopteridaceae	
<b>Epiphytes/Climbers</b>				
1	<i>Cissus elongata</i> Roxb.	Charcharey lahara	vitaceae	100-1100
2	<i>Climatis acuminata</i> DC		Rununculaceae	2200-2400
3	<i>Clematis buchananiana</i> DC	Pinasey lahara	Rununculaceae	1200-3000
4	<i>Codonopsis viridis</i> Wallich.	Padey lahara	Campanulaceae	1100-3100
5	<i>Coelogyne flaccida</i> (Lindl.) Kuntz.	Sunakhari	Orchidaceae	1000-1800
6	<i>Dendrobium chrysanthum</i>		Orchidaceae	800-2000
7	<i>Mucuna macrocarpa</i> Wall.	Baldengra	Leguminosae	1000-1800
8	<i>Piper boehmeriifolium</i> (Miquel) Wallich ex C. DC	Chambo	Piperaceae	500-2200

9	<i>Rhapidiphora decursiva</i> (Roxb.) Schott.	Kanchirno	Araceae	500-1500
10	<i>Rubia manjith</i> Roxb. ex Fleming	Majito	Rubiaceae	700-3600
11	<i>Smilax zeylanica</i> Linn.	Kukur dainey	Liliaceae	450-1500
12	<i>Trichosanthes lepiniana</i> (Naud.) Cogn.	Indreni	Cucurbitaceae	700-1900
13	<i>Viscum articulatum</i> Burm. f.	Harchur	Lorantahceae	100-1700
14		Boksi lahara		
15		Chaulane lahara		
16		Titey lahara		
<b>Bamboos</b>				
1	<i>Arundinaria hookeriana</i> Munro	Pareng	Poaceae	1600-3800
2	<i>Sinarundinaria intermedia</i>	Nigalo/Tite nigalo	Poaceae	1200-1900
3	<i>Schizostachyum capitatum</i>	Gope bans	Poaceae	

## Recommendation

1. The sanctuary is home to Red panda, the state animal of Sikkim, which is a foraging mammal and mostly relies on bamboo grasses. Sometimes they feed upon insects, eggs and rodents, etc. The forest fire has degraded the habitat of Red panda. Numerous incidences of forest fires in the past has damaged forest ecosystem. In future proper management plan needs to be followed to tackle such incidence and protecting the habitats for wildlife and the forest ecosystem. It has altered the demography of the area as these areas are now dominated by species such as *Symplocos glomerata*, *Symplocos theifolia*, *Gerardiana diversifolia*, *Urtica dioica* and *Urtica parviflora*, etc. Such species are suppressing the growth of other important species. It has to be controlled from further expansion in the forest otherwise it will hamper the habitat of other valuable species. These species has totally blocked the wildlife passage making difficult for the wildlife to cross in the forest.
2. There are complaints from the villagers regarding the crop and property damage done by the Himalayan black bear. They are bearing the loss of crop damages because most of the farmers are mainly dependent on the farming and allied related occupation which is the only source of their livelihoods. So they want proper management of wildlife.
3. Most of the forest area is mostly dominated by the *Symplocos glomerata* and *Symplocos theifolia* and which can be considered as invasive species of the forest. The natural regeneration of these species is good compared to oak species. Oak species lacked natural regeneration. Mostly, oak species (*Catanopsis* spp and *Quercus* spp) were old, matured and decayed. Such trees should be removed and good quality of planting material should be planted. Oak species being the keystone species should be preserved for healthy ecosystem in the forest. Its acorns are eaten by squirrels, deer, birds and rodents because it is highly nutritious as it contents protein, fats, vitamins, potassium, etc. The large canopy provides shelter to red panda and other faunal and avi-funal species. So proper management plan should be framed for Oak species as they are the backbone of the forest because they help in maintaining the healthy ecosystem.





*Dendrobium chrysanthum*



*Acer* sp



*Toona ciliata*



*Gerardiana diversifolia*



*Piper* sp



*Viburnum erubescence*

**Checklist of Fauna & Avi-fauna Species recorded in the sampling plots along Sang-Tinjurey  
(Fambong Lho Wildlife Sanctuary) East Sikkim.  
Faunal Species**

S.No	Common Name	Zoological Name	Family	IUCN Status
1	Barking deer	<i>Muntiacus muntjak</i>	Cervidae	LC
2	Himalayan black bear	<i>Ursus thibetanus</i>	Ursidae	V
3	Yellow throated marten	<i>Martes flavigula</i>	Mustelidae	LC
4	Himalayan serow	<i>Capricornis thar</i>	Bovidae	NT
5	Jackal	<i>Cannis aurens</i>	Canidae	T
6	Giant flying squirrel	<i>Petaurista magnificus</i>	Sciuridae	LC
7	Himalayan palm civet	<i>Paguma larvata</i>	Viverrids	LC
8	Wild pig	<i>Sus scrofa</i>	Suidae	LC
<b>Avi-Faunal Species</b>				
1	Black bulbull	<i>Hypsipetes madagascariensis</i>	Pycnonotidae	LC
2	Black drongo	<i>Dicrurus macrocerus</i>	Dicaeidae	LC
3	Blue whistling thrush	<i>Myophoneus caeruleus</i>	Turdidae	LC
4	Common cuckoo	<i>Cuculus canorus</i>	Cuculidae	LC
5	Common green magpie	<i>Cissa chinensis</i>	Corvidae	LC
6	Common hill partridge	<i>Arborophila torqueola</i>	Phasinidae	LC
7	Dull green leaf warbler	<i>Phylloscopus trochiloides</i>	Sylviidae	LC
8	Himalayan tree pie	<i>Dendrocitta formosae</i>	Corvidae	LC
9	Kalij Pheasant	<i>Lophura leucomelana</i>	Phasinidae	LC
10	Long tailed mountain thrush	<i>Zoothera dixonii</i>	Turdidae	LC
11	Nepal sunbird	<i>Aethopyga nepalensis</i>	Nectariniidae	LC
12	Red-headed tit	<i>Aegithalos concinnus</i>	Paridae	LC
13	Rufous turtle dove	<i>Streptopelia orientalis</i>	Columbidae	V
14	Satyr tragopan	<i>Tragopan satyra</i>	Phasinidae	NT
15	Scarlet minivet	<i>Pericrocotus flammeus</i>	Campephagidae	LC
16	Striated laughing Thrush	<i>Garrulax striatus</i>	Turdidae	LC
17	Wedge-tailed green pigeon	<i>Treron sphenura</i>	Columbidae	LC
18	White crested laughing thrush	<i>Garrulax leucolophus</i>	Turdidae	LC
19	Yellow-naped yuhina	<i>Yuhina flavicollis</i>	Timaliidae	LC

NT: Near Threatened, T: Threatened, V: Vulnerable, LC: Least Concern,



## Monitoring of Kitam Bird Sanctuary, South Sikkim

*Nimesh Chamling & Dorjee Chewang Bhutia*

Kitam Bird Sanctuary (KBS) in South Sikkim is popular destination especially for Peafowl within the state and is the only bird sanctuary in Sikkim. It was declared as sanctuary in 2006 vide notification number 37/FEWMD dated 17<sup>th</sup> June 2006 under the provision of wildlife (Protection) Act, 1972. Revisit as the part of monitoring was conducted in the sanctuary after a gap of three years. It is carried mainly to observe the changes in the vegetation within the sample plots conducted in the past. The sanctuary is promoted as potential eco-tourism zone under JICA-assisted-Sikkim Biodiversity Conservation and Forest Management Project (SBFP) due to its rich ecological, floral, faunal and natural significance. Due to its uniqueness the residence of Kitam village are enjoying the benefits from it and their socio-economic status has improved. The area of the sanctuary is 6.0 Km<sup>2</sup> and is located in the tropical eco-region at an altitudinal range of 320-875m from the mean sea level.



*Phoenix sylvestris* habitat in Kitam Bird Sanctuary



An area upto 25m from the boundary of sanctuary has been extended and notified as an eco-sensitive zone, where lies the two villages namely Upper Kitam and Lower Kitam. These villages are extended up to the outer bank of the river Rangeet. The eco sensitive zone of the sanctuary lies between 27°15'53"N to 27°7'15"N latitude and 88°21'17"E to 88°21'51"E longitude bordering with Gorkhaland Territorial Administration under West Bengal by Great Rangeet River. The slope angle of the sampled sites ranged between (10° to 40°) and face towards E, N and NE aspect. The area is prone to the forest fire due to the stagnant of needle leaves fallen on the forest floor from chir pine (*Pinus roxburghii*) tree. When these needles get dried up they easily catches fire. It is a continuous phenomenon especially during dry seasons in March-April. This has caused severe damage to the biodiversity of the area. So from time to time prescribed burning is needed to ensure healthy growth of grasses during monsoon season and which will be available for the wild animals.



**Chir Pine stands in Kitam Bird Sanctuary**

The sanctuary is dominated by the Sub-Tropical Moist forest types consisting of unique association of *Shorea robusta* (Sal), *Tectona grandis* (Teak) and *Pinus roxburghii* (Chir Pine). We noticed that much of the broad sized sal and teak trees were entangled by lianas. This depicts the peculiar characteristic of sub-tropical forest. Ground is mostly covered by leaf litters of sal teak and chir pine needles. There were countable seedlings and saplings of sal and teak. Regeneration was missing in case of chir pine. Barren areas and gaps were

occupied by the seedlings and saplings of *Phoenix sylvestris*. The other plant species present in the sanctuary were *Terminalia bellirica*, *Chukrasia tabularis*, *Terminalia chebula*, *Castanopsis hystrix*, *Alstonia scholaris*, *Bischofia javanica*, *Cassia fistula*, *Macaranga denticulate*, *Erythrina indica*, *Albezia procera*, *Bauhinia purpurea*, *Delonix regia*, *Daubanga latifolia*, *Ficus religiosa*, *Schima wallichii*, etc.



**Overview of Forest Composition of Kitam Bird Sanctuary, South Sikkim**

The sanctuary is famous for peafowl (*Pavo cristatus*) which is the national bird of our country and is the only habitat in the state. It also harbors other mammalian species such as wild pig (*Sus scrofa*), Chinese pangolin (*Manis pentadactyla*), Himalayan Palm Civet (*Paguma larvata*), Common Leopard (*Panthera pardus*), Crestless Porcupine (*Hystrix brachyuran*). The sanctuary is also favorable for the Rock Paython (*Python molurus*) to survive. It is a large, non-venomous and native of tropical and sub-tropical regions of the Indian sub-continent and South-East Asia. The sanctuary is also the habitat for Assamese macaque, which is classified as macaque of the old monkey world. As per the Red data book under IUCN, the species has been listed as ‘near threatened’ because its population is decreasing due to hunting, habitat degradation and fragmentation, etc. The sanctuary also harbors avi-faunal species such as Black Crested Bulbul, Common Green Magpie, Common



Myna, Red-Vented Bulbul, Ashy Drongo, etc. The common butterflies include Golden sapphire, Indian Tortoise Shell, Cabbage White, Common Grass Yellow, etc.

## STUDY AREA

The current monitoring was carried out in Kitam Bird Sanctuary, South Sikkim in the month of September, 2019. The altitude of the surveyed path ranged from 385m-781m (msl). The forest lies between 27.10'69.9"- 27.10'47.4"Latitude (N) and 88.34'93.0"- 88.34'89.2"Longitude (E).The slope angle of the surveyed area ranged from 10° to 40° and the aspect facing towards E, N, and NE. The average depth of the humus is 4 cm and the Canopy Cover is between 40%-80%.

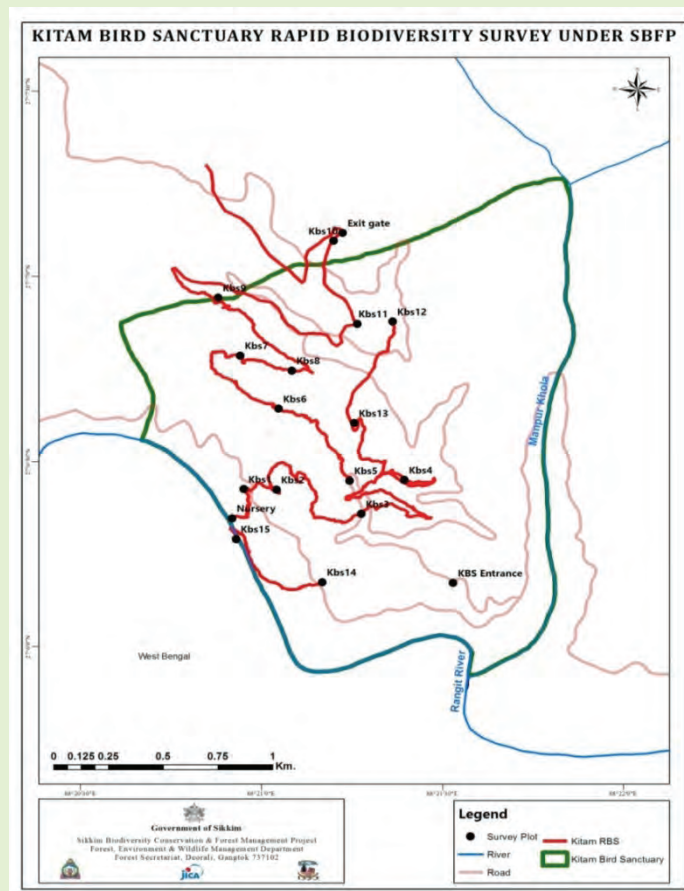


Figure 2. Map showing the sample plots along Kitam Bird Sanctuary, South Sikkim.

## FINDINGS AND DISCUSSION

During the survey, a total of 15 plots were laid covering 0.15 ha from the same sample plots of the previous Rapid Biodiversity Survey conducted. Total of 32 trees, 7 small tree/ shrubs, and 6 herb species were recorded. A general checklist of 110 species of the area (including the areas outside of the plots) were also prepared, of which, trees represented the highest number of species (60 species belonging to 48 genus and 32 families) followed by small tree/large shrub represented by 17 species belonging to 14 genus and 9 families; 20



species of herbs represented by 17 genus , 8 families and 1 unidentified, 16 species of epiphytes/climbers with 11 genus, 8 family and 2 unidentified, 17 ferns& fern-allies (belonging to 11 genus, 10 families) and 1 bamboo species were recorded. Family wise analysis revealed that Moraceae to be the most dominant tree family with 5 species, followed by Meliaceae, Fabaceae and Euphorbiaceae with 4 species each and Lythraceae, Combretaceae and Verbenaceae with 3 species each, while in the case of small trees or shrubs Asteraceae with 4 species appeared as the dominant family. In case of herbs, Poaceae family appeared to be the most dominant with 13 species. While in ferns & fern-allies Pteridaceae was the dominant family with 5 species and Thelypteridaceae with 4 species.



**Acorns of *Castanopsis indica***

The first rapid biodiversity survey in Kitam Bird Sanctuary was conducted during March 2016. As per the methodology, for monitoring of the area, there should be gap of three years. The monitoring in Kitam Bird Sanctuary was conducted in the month of August 2019. The forest type of sanctuary is Sub-Tropical moist deciduous forest stand mainly dominated by the sal and teak species in association with chir pine. The other main tree species of the sanctuary are *Alstonia scholaris*, *Bauhinia purpurea*, *Bischofia javanica*, *Bombax ceiba*, *Gmelina arborea*, *Phoenix sylvestris*, *Dubanga Grandiflora*, *Dubanga Grandiflora*.

Along the stretches of National Highway inside the Sanctuary the forest department had planted mostly ornamental tree species such as *Delonix regia*, *Lagerstroemia speciosa*, *Cassia fistula*. Apart from it the area is mainly dominated by tree species such as *Bischofia javanica*, *Bombax ceiba*, *Bauhinia purpurea*, *Alstonia scholaris*, *Albizia procera*, *Albizia lebbek*, *Artocarpus heterophyllus*, *Bombax ceiba*, *Chukrasia tabularis*, *Dubanga Grandiflora*, *Erythrina stricta*, *Gmelina arborea*, *Litsea monopeltata*, *Macaranga denticulate*, *Ziziphus jujube*, *Toxicodendron wallichii*, *Terminalia chebula*, *Terminalia belerica*, *Syzygium cumini*. The ground vegetation is mostly dominated by *Neprolepisauriculata*, *Mimosa pudica*, *Thysanolaena latifolia*, *Mikania micrantha*. While the

site located near the river Teesta *Dubanga Grandiflora* and *Bombax ceiba* were the common tree species.

While the road diverting from the main National Highway starting from the sanctuary entry gate leading towards the Kitam village, where we could notice slight change in the vegetation. Here the most dominating tree species were *Shorea Robusta*, *Tectona grandis*, and *Pinus Roxburghii*. The other associated tree species present in this site were *Erythrina stricta*, *Alstonia scolaris*, *Ailanthus integrifolia*, *Grewia optiva*, *Macaranga denticulate*, *Morus australis*, *Schima wallichii*.

## Fauna

During the trail 7 mammalian belonging to seven families species were recorded from Sang-Tinjurey sampling path and is presented in the Table below. Some of the evidences are from direct sightings and indirect evidences (pellet, scat, killed, dung, digging/foraging sign, droppings and feathers). Total of 14 birds species were recorded from Kitam Birds sanctuary, South Sikkim.

**Site characteristics of the sampling plots along Kitam Birds Sanctuary, South Sikkim**

Site code	Forest Type	Altitude (M)	GPS		Slope (deg.)	Slope Aspect	Canopy cover (%)
			Lat	Long			
KBS 01	Sub-Tropical Broad Leaved Forest	385	27.10'69.9"	88.34'93.0"	35	E	60
KBS 02	Sub-Tropical Broad Leaved Forest	410	27.10'69.5"	88.35'08.1"	30	E	60
KBS 03	Sub-Tropical Broad Leaved Forest	487	27.10'58.2"	88.35'47.2"	20	E	60
KBS 04	Sub-Tropical Broad Leaved Forest	560	27.10'73.3"	88.35'67.1"	10	E	80
KBS 05	Sub-Tropical Broad Leaved Forest	571	27.10'73.2"	88.35'41.7"	30	E	70
KBS 06	Sub-Tropical Broad Leaved Forest	559	27.11'06.3"	88.35'09.4"	20	N	80
KBS 07	Sub-Tropical Broad Leaved Forest	586	27.11'30.2"	88.34'92.0"	30	N	60
KBS 08	Sub-Tropical Broad Leaved Forest	632	27.11'23.0"	88.35'15.8"	30	N	70
KBS 09	Sub-Tropical Broad Leaved Forest	689	27.11'56.1"	88.34'82.2"	30	NE	60
KBS 10	Sub-Tropical Broad Leaved Forest	781	27.11'81.2"	88.35'35.7"	10	E	60
KBS 11	Sub-Tropical Broad Leaved Forest	741	27.11'43.7"	88.35'46.2"	20	E	70
KBS 12	Sub-Tropical Broad Leaved Forest	693	27.11'44.6"	88.35'62.5"	30	E	70
KBS 13	Sub-Tropical Broad Leaved Forest	615	27.10'99.1"	88.35'44.3"	35	NE	70
KBS 14	Sub-Tropical Broad Leaved Forest	333	27.10'27.7"	88.35'28.7"	40	NE	60
KBS 15	Sub-Tropical Broad Leaved Forest	305	27.10'47.4"	88.34'89.2"	40	NE	50

**Checklist of Floral Species recorded in the sampling plots along Kitam Birds Sanctuary,  
South Sikkim**

Sl. No	Botanical Name	Local name	Family	Altitudinal Range (m)
<b>TREES</b>				
1.	<i>Actinodaphne obovata</i> (Nees) Blume	Runchay	Lauraceae	300-1400
2.	* <i>Ailanthus integrifolia</i> Lam.	Gokul	Simaroubaceae	450-700
3.	<i>Alangium chinense</i> (Lour.) Harms	Singarey	Alangiaceae	240-2000
4.	<i>Alangium begoniaefolium</i> (Roxb.) Baill	Akhanay	Alangiaceae	450-2000
5.	<i>Albezia chinensis</i> (Osbeck) Merr.	Rato siris	Fabaceae	450-1500
6.	<i>Albezia procera</i> (Roxb.) Benth.	Seto siris	Fabaceae	400-1200
7.	<i>Alstonia scholaris</i> (L.) R.Br.	Chattivan	Apocynaceae	300-1000
8.	* <i>Aphanamixis polystachya</i> (Wall.) Parker.	Lasunay	Meliaceae	600-1800
9.	<i>Artocarpus lacucha</i> Hamilton	Badahar	Moraceae	300-1500
10.	<i>Artocarpus heterophyllus</i> Lam.		Moraceae	300-1000
11.	<i>Bauhinia purpurea</i> L.	Taaki	Caesalpiniaceae	300-1500
12.	<i>Bauhinia veriagata</i> L.	Koiralo	Caesalpiniaceae	300-1800
13.	* <i>Bischofia javanica</i> Blume	Kaijal	Bischofiaceae	400-1500
14.	<i>Boehmeria rugulosa</i>	Daar	Urticaceae	300-700
15.	* <i>Bombax ceiba</i> L.	Simal	Bombacaceae	300-1200
16.	* <i>Bridelia retusa</i> (L.) Spreng	Gayo	Euphorbiaceae	400-1500
17.	<i>Castanopsis indica</i> A.DC	Dhalne katus	Fagaceae	300-1000
18.	<i>Callicarpa arborea</i> Roxb.	Guenlo	Verbenaceae	400-1500
19.	<i>Cassia fistula</i> L.	Rajvriksha	Caesaiaceae	Upto 1400
20.	<i>Celtis timorensis</i> Span.	Khari	Ulmaceae	300-600
21.	* <i>Chukrasia tabularis</i> A.Juss.	Chukrasay	Meliaceae	300-1200
22.	<i>Delonix regia</i> (Hook.) Raf.	Golmaar	Fabaceae	200-1500
23.	<i>Citrus maxima</i> (Burman) Merrill	Foksay	Rutaceae	300-1800
24.	<i>Diploknema butyracea</i> (Roxb.) H.J.Lam	Chiuri	Sapotaceae	700-1500



25.	* <i>Dubanga Grandiflora</i> (Roxburgh ex Candolle) Walpers, Repert.	Lampatey	Lythraceae	Upto 1000
26.	<i>Erythrina stricta</i> Roxb.	Faledo	Fabaceae	300-1600
27.	<i>Ficus auriculata</i> Lour.	Nevaro	Moraceae	300-1500
28.	<i>Ficus benjamina</i> L.	Sami	Moraceae	400-1200
29.	<i>Firmiana colorata</i> R.Br.	Phirpheray	Sterculiaceae	300-900
30.	* <i>Ficus semicordata</i> Buch.-Ham.ex Sm.	Khasrey khaniu	Moraceae	600-1500
31.	* <i>Garuga pinnata</i> Roxb.	Dabdabey	Burseraceae	300-1200
32.	* <i>Gmelina arborea</i> Roxb.	Khamari	Verbenaceae	200-1000
33.	* <i>Grewia optiva</i> J.R.Drumm.ex Burret	Syal Phusray	Malvaceae	Upto 1800
34.	* <i>Largerstroemia parviflora</i> Roxb.	Budo Dhayero	Lythraceae	200-900
35.	<i>Largerstroemia speciosa</i> (L.) Pers.	Jarul	Lythraceae	300-900
36.	* <i>Litsea monopeltata</i> (Roxb.) Persoon	Kutmero	Lauraceae	300-1500
37.	<i>Macaranga denticulata</i> (Blume) Muell.	Malato	Euphorbiaceae	400-1000
38.	* <i>Mallotus philippensis</i> (Lam.) Mull.Arg.	Sinduray	Euphorbiaceae	300-1600
39.	<i>Melia azedarach</i> L.	Bakaino	Meliaceae	300-1600
40.	<i>Morus australis</i> Poir.	Kimbu	Moraceae	350-2000
41.	* <i>Neonauclea purpurea</i> (Roxb.) Merr.	Kadam	Rubiaceae	300-750
42.	<i>Oroxylum indicum</i> (L.) Vent.	Totala	Bignoniaceae	300-1500
43.	<i>Pandanus furcatus</i> Roxb.	Tarika	Pandanaceae	200-1500
44.	* <i>Phyllanthus emblica</i> L.	Aamla	Euphorbiaceae	300-1500
45.	* <i>Pinus Roxburghii</i> Sarg.	Chirpine	Pinaceae	400-2500
46.	* <i>Phoenix sylvestris</i> (L.) Roxb.	Thakkal	Arecaceae	300-1200
47.	* <i>Schima wallichii</i> (DC.) Korth	Chilauney	Theaceae	400-1800
48.	* <i>Shorea Robusta</i> Gaertn.	Sakhua / Sal	Dipterocarpaceae	100-1500
49.	* <i>Stercolia villosa</i> Roxb.	Odal	Malvaceae	
50.	* <i>Syzygium cumini</i> (L.) Skeels	Jamuna	Myrtaceae	300-1200

51.	* <i>Syzygium kurzii</i> (Duthie)N.P.Balacr.	Amboke	Myrtaceae	150-700
52.	* <i>Taxodium</i> sp.	Tarpin	Taxodiaceae	Planted
53.	* <i>Tectona grandis</i> L.f.	Saigun/ Teak	Verbenaceae	100-600
54.	* <i>Terminalia belerica</i> (Gaertn.)Roxb.	Barro	Combretaceae	300-1200
55.	* <i>Terminalia chebula</i> Retz.	Harro	Combretaceae	400-1500
56.	* <i>Terminalia crenata</i> (Gaertn.)Roxb.	Pakha saaj	Combretaceae	250-1000
57.	* <i>Tetrameles nudiflora</i> R.Br.	Maina	Tetramelaceae	200-900
58.	* <i>Toona ciliata</i> Roem.	Tooni	Meliaceae	300-1700
59.	* <i>Toxicodendron wallichii</i> (Hook.f.)Kuntze	Valayo	Anacardiaceae	500-2000
60.	<i>Ziziphus jujuba</i> Mill.	Bayer	Rhamnaceae	300-900
	<b>Shrubs</b>			
1.	<i>Abrus precatorious</i>			
2.	* <i>Ageratina adenophora</i> (Spreng.) King & Robinson	Kali Jhar	Asteraceae	300-2000
3.	<i>Ageratum conyzoides</i> L.	Elamey	Asteraceae	200-2000
4.	<i>Atemisia indica</i> Willd.	Titepati	Asteraceae	300-2400
5.	<i>Bidens pilosa</i> Linn	Kuro	Asteraceae	300-2400
6.	<i>Boehmeria macrophylla</i> D.	Kamley	Urticaceae	Upto 1860
7.	<i>Cheilocostus speciosus</i> (J. Konig) C. Specht.	Betlauri	Costaceae	300-1800
8.	* <i>Clerodendron</i> sp			
9.	<i>Colebrookea oppositifolia</i> Smith.	Dhusrey	Lamiaceae	200-1700
10.	* <i>Lantana camara</i> Linn.	Banmara	Verbenaceae	300-1700
11.	<i>Leucocephtrum</i> sp	Bhimsen pati	Lamiaceae	
12.	<i>Rubus diffusus</i> Sm.	Aiselu	Rosaceae	
13.	<i>Solanum turvum</i> Swartz.	Jangali Behi	Solanaceae	300-1500h
14.	<i>Vitex nigundo</i> L.	Simali	Verbenaceae	300-1500
15.	<i>Woodfordia fruticosa</i> (L.) Kurz.	Dhayero	Lythraceae	
16.	*	Maitalu Kanra		
17.	*	Phirphiray		
	<b>Herbs</b>			
1.	<i>Agave Americana</i> L.	Hattibar	Agavaceae	359-1200
2.	<i>Alternanthera sessilis</i> (L.) R.Br.ex DC.	Bhringi jhaar	Amaranthaceae	350-1500

3.	<i>Arundinaria</i> sp.	Musey kharuki	Poaceae	
4.	<i>Capillipedium</i> sp.	Thulo kharuki	Poaceae	
5.	<i>Eragrostis</i> sp	Chaptey banso	Poaceae	
6.	<i>Eragrostis</i> sp	Ghoday banso	Poaceae	
7.	* <i>Eragrostis</i> sp.	Banso	Poaceae	
8.	<i>Eragrostis</i> sp.	Jangali banso	Poaceae	
9.	<i>Gonostegia hirta</i> (Blume ex Hassk.) Miq.	Chiplay	Urticaceae	500-2600m
10.	* <i>Hedychium</i> sp.	Sara	Zingiberaceae	
11.	<i>Imperata cylindrica</i>	Siru	Poaceae	300-2400m
12.	<i>Ischaemum rugosum</i> Salisb	Babyo	Poaceae	100-1800m
13.	* <i>Jasminum</i> sp.		Oleaceae	
14.	<i>Mikania micrantha</i> Kuntha		Asteraceae	300-1500
15.	<i>Mimosa pudica</i> L.	Buhari jhar	Mimosaceae	300-1500
16.	* <i>Neyraudia arundinaceae</i> (L.)	Ghungring	Poaceae	200-2000m
17.	<i>Phlogacanthus pubinervius</i> T.Anderson	Titay	Acanthaceae	200-1700m
18.	* <i>Poa</i> sp	Phurkay	Poaceae	
19.	* <i>Setaria palmifolia</i> (J.Koenig) Stapf	Dhoti sara	Poaceae	300-1800m
20.	* <i>Thysanolaena latifolia</i> (Roxb.ex Hornem.) Honda	Amliso	Poaceae	300-1800
21.		Gahatay jhar		
<b>Ferns &amp; Fern allies</b>				
1	<i>Adiatum concinnum</i> Humb.	Uniu	Adiantaceae	Up to 1400
2	<i>Aleuritopteris anceps</i> (Banf.) Panigrahi	Rani Uniu	Pteridaceae	Up to 1500
3	<i>Angiopteris helferiana</i> C.Presl	Uniu	Marrattiaceae	400-1000
4	<i>Blechnum orientale</i> L.	Uniu	Blechnaceae	Up to 1500
5	<i>Leptochilus hemionitides</i> (C.Presl) Nooteboom		Polypodiaceae	Up to 1000
6	<i>Lygodium flexuosum</i> (L.) Sw.	Lahare Uniu	Lygodiaceae	Up to 1000
7	<i>Microlepia speluncae</i> (L.) T.Moore		Dennstaedtiaceae	100-1100m
8	<i>Neprolepisauriculata</i> (L.) Trimen	Pani amala	Nephrolepidaceae	300-2000



9	<i>Neprolepis cordifolia</i> (L.) C.Presl	Paani amala	Oleandraceae	Up to 2000
10	<i>Onychium siliculosum</i> (Desv.) C.Chr		Pteridaceae	Up to 1200
11	<i>Pteris biaurita</i> L.		Pteridaceae	Up to 1800
12	<i>Pteris ensiformis</i> Burmn.f.	Uniu	Pteridaceae	400-600
13	<i>Pteris subindivisa</i> C.B. Clarke		Pteridaceae	Up to 700
14	<i>Thelypteris</i> (Christella) arida (D.Don)	Uniu	Thelypteridaceae	Up to 1500
15	<i>Thelypteris</i> (Christella) <i>crinipes</i> (Hook) K. Iwats	Uniu	Thelypteridaceae	400-800
16	<i>Thelypteris</i> (Christella) <i>dentate</i> (Forsskl.) E.P.St.John.	Uniu	Thelypteridaceae	500-1800
17	<i>Thelypteris</i> (Macrothelypteris) <i>ornate</i> (Wall. Ex Bedd.) Ching	Uniu	Thelypteridaceae	Up to 1000
<b>Climbers/ Epiphytes</b>				
1.	<i>Acacia pinnata</i> (L.)Willd.	Arari	Fabaceae	200-1200m
2.	<i>Asparagus racemosus</i> Willd.	Kurilo	Liliaceae	200-1500m
3.	<i>Bauhinia vahlii</i> Wight & Arn.	Bhorlo	Caesalpiniaceae	200-1500m
5.	<i>Dioscorea pentaphylla</i> L.	Bantarul	Dioscoreaceae	300-1800m
6	<i>Dioscorea</i> sp.			
7.	<i>Ficus sarmentosa</i> Buch.	Duday lahara	Moraceae	500-2500m
8.	<i>Mikania micrantha</i> Kuntha		Asteraceae	300-1700m
9.	<i>Mucuna imbricate</i> DC.	Kauso	Fabaceae	Upto 1000
11.	<i>Piper boehmeriaefolium</i> (Miq.) DC.	Jungali pan	Piperaceae	500-2200m
12.	<i>Piper</i> sp.	Chabo/ Pan	Piperaceae	
13.	<i>Smilax</i> sp.	Kukurdainey	Liliaceae	
14.	<i>Spatholobus parviflorus</i> (DC.) Kuntze	Debre lahara	Fabaceae	200-2000m
15.		Pareyandrey		
16.		Darmay Kanra		
<b>Bamboo</b>				
1.	<i>Dendrocalamus hamiltonii</i> Nees & Arn.ex Munro	Choya bans	Poaceae	700-4000m
<b>Note: (*) represents the species recorded inside the sample plots.</b>				

**Checklist of Fauna & Avi-fauna Species recorded in the sampling plots along Kitam  
Birds Sanctuary, South Sikkim**

<b>Faunal Species</b>				
<b>S.No</b>	<b>Common Name</b>	<b>Zoological Name</b>	<b>Family</b>	<b>IUCN Status</b>
1	Assamese macaque	<i>Macaca assamensis</i>	Cercopithecidae	NT
2	Barking Deer	<i>Muntiacus muntjak</i>	Cervidae	LC
3	Chinese Pangolin	<i>Manis pentadactyla</i>	Manidae	CE
4	Common Leopard	<i>Panther pardus</i>	Felidae	V
5	Himalayan palm Civet	<i>Paguma larvata</i>	Viverridae	LC
6	Indian Crested Porcupine	<i>Hystrix sp.</i>	Erithizontidae	LC
7	Wild pig	<i>Sus scrofa</i>	Suidae	LC
<b>Avi-Faunal Species</b>				
1	Ashy Drongo	<i>Dicrurus leucophaeus</i>	Dicaeidae	
2	Black-crested Bulbul	<i>Pycnonotus flaviventris</i>	Pycnonotidae	LC
3	Blue-throated Barbet	<i>Megalaima asiatica</i>	Megalaimidae	LC
4	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	Turdidae	LC
5	Common Myna	<i>Acridotheres tristis</i>	Sturnidae	LC
6	Common Pigeon	<i>Columba livia</i>	Columbidae	
7	Common Green Magpie	<i>Cissa chinensis</i>	Corvidae	LC
8	House Crow	<i>Corvus splendens</i>	Corvidae	LC
9	House Sparrow	<i>Passer domesticus</i>	Passeridae	E
10	Indian Peafowl	<i>Pavo cristatus</i>	Phasianidae	LC
11	Kalij Pheasant	<i>Lophura leucomelanos</i>	Phasinidae	LC
12	Oriental white eye	<i>Zosterops palpebrosus</i>	Zosteropidae	LC
13	Red Junglefowl	<i>Gallus gallus</i>	Phasianidae	LC
14	Red-vented bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	LC
<b>CE: Critically Endangered, E: Endangered, V: Vulnerable, NT: Near Threatened, LC: Least Concern</b>				

**Recommendation:**

1. There is a concern from the locality of the nearby villages of constant incidence of crop damage by peafowl, which has lead to a huge loss of crop produce. There is also the concern of peafowl increasing numbers in the sanctuary. So they want proper management plan of the peafowl in the sanctuary.
2. The sanctuary falls in the sub-tropical moist deciduous forest type and is mainly dominated by the Chir pine, Sal and Teak species. The fallen leaves of these species get stagnated on the ground and dries up. When this debris is left out in the wild without disposing them properly, it becomes more susceptible towards forest fire

mainly in dry winter season. So proper disposal of the debris is essential from future incidence of forest fire.

3. The back cutting and road widening work in the sanctuary has exposed the soil surface which and has become more susceptible to soil erosion. So proper soil management techniques are required to protect the soil from further erosion.
4. The sanctuary is also home to Chinese Pangolin (*Manis pentadactyla*), which has been categorized as critically endangered under IUCN Red List. The main threat of this species is poaching and illegal wildlife trade. So a proper conservation plan is to be taken up in order to protect this species from different threats.
5. As the sanctuary is mostly dominated by the pure stands of Chir pine, Sal and teak. Sal and teak species are an important timber species because they have quality wood. Silviculture techniques such as tending, thinning and cleaning is required to remove the over matured, dead, decayed and inferior quality tree boles from the stands. Through these it gives the space for the other trees to grow vigorously in the stands.



*Delonix regia*



*Lagerstroemia speciosa*



*Ageratina altissima*



*Artocarpus heterophyllus*





*Pinus roxburghii*



*Alstonia scholaris*



*Pandanus furcatus*



*Bauhiniavahlia*



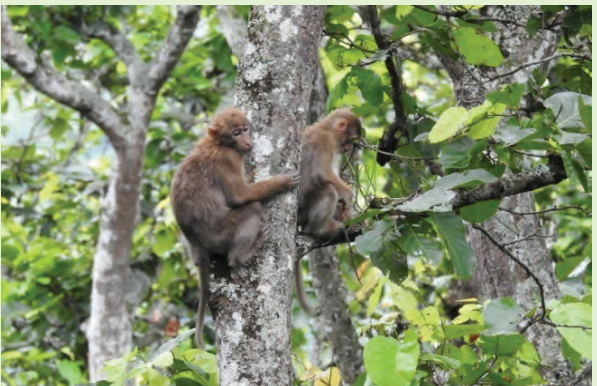
*Tectona grandis*



*Shorea robusta*



*Great Eggfly*



*Assamese Macaque*



# MONITORING AND EVALUATION OF BIODIVERSITY OF THANGU-LASHAR VALLEY, NORTH SIKKIM

*Sabita Dahal and Sanchi Subba*



## STUDY AREA

A field trip for conducting monitoring and evaluation of biodiversity of Thangu – Lasher Valley (revisit) were conducted after two years of Rapid Biodiversity Survey under SBFP especially to observe and evaluate changes on biodiversity. The survey was done covering a sampling path along Gay-Gaon – Nanghraylha - upto Yathang sampling path during August 2019 (post monsoon).

The present survey area along Gay-Gaon- Lashar – Yathang sampling path, the forest type of which is represented by sub-alpine forest to alpine scrub. The elevation range covered during the survey was from 3655m [Yathang (Below Thangu)] to 4850m [Nanghray-lha (Lashar valley)], which is represented by **Fig 1**. The slope angle of the area ranged between mild (10 degree) to stiff (85 degree) slope and was faced towards E, SE, N, NW, W, NE and SW aspect (**Table 1**.)



**Plate 1. Forest types of Thangu – Lashar Valley, North Sikkim**

Forest being sub alpine to alpine type, herbs are the most predominant taxa in the area, followed by shrubs and shrublets. The area constitutes the wide range of habitat diversity including several globally threatened species as well as high value medicinal plants such as *Aconitum spicatum*, *Ephedra gerardiana* var *sikkimensis*, *Rheum nobile*, *fritillaria cirrhosa*, *Podophyllum hexandrum*, *Sassurea obvallata*, *Meconopsis simplicifolia* etc. The lower elevation of the study area, below Thangu valley is occupied mainly with scattered *Abies densa*, *Salix* sp. and the species of *Rhododendrons*. In addition, the area also provide diverse habitat for faunal species such as Serow, Musk Deer, Blood Pheasant, Leopard, Lesser Cats and Himalayan Marmot, Satyr Tragopan, Common Langur, Tibetan Fox, Martens Weasel and Impeyan Pheasant. A wide variety of avifauna, which includes Blood Pheasant, Monal Pheasant, Tragopan, Rose finches, Red-billed Chough, Forktails and Laughing Thrushes also resides in the area.





Sub-alpine forest, dominated by *Abies densa*, *Betula utilis*, *Salix sp.* (3800m and below)



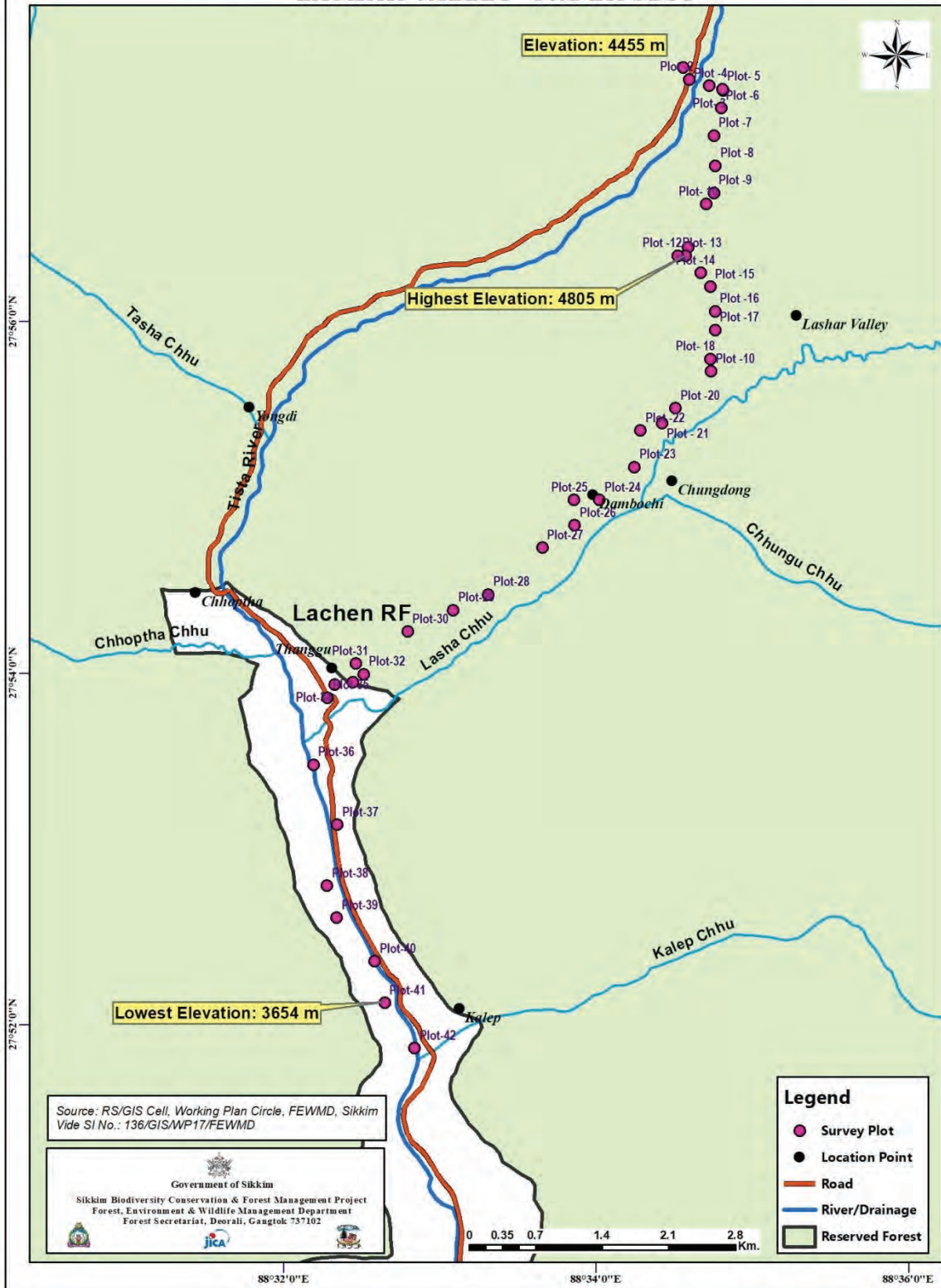
Alpine Scrub (4000m)



Alpine meadows, above 4500m



## RAPID BIODIVERSITY SURVEY PLOTS AT THANGU TO LASHAR VALLEY UNDER SBFP



## METHODOLOGY

Monitoring and evaluation of biodiversity were done using Rapid Biodiversity Survey Techniques (RBST). Prior to field work, Previous RBS report of the area along with other relevant literatures was scrutinized to have an idea about the biodiversity of the area. The checklist of the species (both flora and fauna) was prepared and was taken to the field to confirm their presence in the study area. During the field work, general listing of all the species occurring in the area (both flora and fauna) were made to have fair knowledge on the biodiversity of the area.

In the field, the quantitative as well as qualitative data on floral biodiversity was recorded using a standard quadrat sampling method, wherein, a random plot of 10m x 10m were established which was followed by lying of plot after every 0.5 to 0.6 km approximate distance. Within the plot, all the tree species were listed and the individual tree width CBH > 30 cm (1.3 m above the ground) was measured. Within the mother plot, a quadrat of 5m x 5m was laid in the centre to record the number of saplings present; the same quadrat was used to record the percent cover of the shrub species. 5 number of 1m x 1m quadrat were laid; 2 at the alternate corners of the 5m x 5m quadrat and 1 at the centre for recording the percent cover of the herb species; the same quadrat was used to record the number of seedlings. General listing of all the species (flora) encountered along the sampling plots as well as outside was also done to have fair idea on the species availability in the area. Parameters such as coordinates and altitude of each sample plots were recorded using hand held GPS; slope aspect and slope angle of each plots were also recorded.

In case of trees, recorded data were analyzed for density, frequency, abundance, basal area etc. Importance value index (IVI) was determined as the sum of percentage density and percentage basal area. Species diversity for each plot was determined with the Shannon and Wiener information function, which reads as  $H' = -\sum (n_i/N) \log_2 n_i/N$ , where 'n<sub>i</sub>' represents total number of individuals of particular species, and 'N' represents total number of individuals of all species. Species richness was calculated using Margalef's index as  $I = (S - 1)/\ln(N)$ , where 'S' = the number of species in the sample and 'N' = the total number of individuals in the sample. Species evenness was determined by Shannon index of evenness as,  $E = H'/\ln(S)$  where 'H' = Shannon' Index of diversity and 'S' = number of species in the sample. Concentration of dominance was measured by Simpson's Index, which reads as,  $D = \sum (n_i/N)^2$  where, 'n<sub>i</sub>' represents total number of individuals of particular species and 'N'



represents total number of individuals of all species. In case of shrubs and herbs, populations were calculated in terms of Average Percent Cover.



To record the faunal element occur in the area, trail sampling (walking through the trail) and sign surveys (records of digging sign, foraging sign, hoof mark, etc.) were made. During the survey, direct evidences like call sound and indirect evidences like feather, pellets, scats, droppings etc. were recorded. Photo capture was also done, depending upon the feasibility.

Then the observations and outcomes (both qualitative and quantitative) were compared with the published report of previous Rapid Biodiversity Survey of the area and other available literatures and interpreted.

**Table1: Field characteristics of the survey area along Gay-Gaon- Lashar – Yathang sampling path, North Sikkim.**

Plots	Forest type	Elevation (m)	GPS Co-ordinates		Slope Angle (°)	Slope Aspect	Location
			Lat (N)	Long (E)			
Plot1	Alpine	4455	27°57' 24.1''	88°34'39.1''	30	E	Gochuphalay
Plot2	Alpine	4450	27°57' 20.0''	88°34'41.2''	45	E	Gochuphalay
Plot3	Alpine	4490	27°57' 16.0''	88°34'54.2''	70	E	Gochuphalay
Plot4	Alpine	4545	27°57' 17.8''	88°34'48.8''	80	E	Gochuphalay
Plot5	Alpine	4589	27°57' 16.6''	88°34'54.0''	70	N	Gochung Pakha
Plot6	Alpine	4605	27°57'10.1''	88°34'53.5''	85	N	Gochung Pakha
Plot7	Alpine	4612	27°57' 00.7''	88°34'50.5''	80	SE	Gochung Pakha
Plot8	Alpine	4650	27°57'50.4''	88°34'50.9''	85	E	Gochung Pakha
Plot9	Alpine	4696	27°56'41.1''	88°34'50.2''	80	N	Shenga
Plot10	Alpine	4742	27°56'37.3''	88°34'47.2''	80	NE	Shenga
Plot11	Alpine	4802	27°56'22.6''	88°34'40.0''	5	N	Nanghray-lha
Plot12	Alpine	4805	27°56'19.8''	88°34'39.1''	5	N	Nanghray-lha
Plot13	Alpine	4800	27°56'19.8''	88°34'35.9''	40	NE	Nanghray-lha
Plot14	Alpine	4762	27°56'13.9''	88°34'44.8''	40	NE	Sachung
Plot15	Alpine	4721	27°56' 09.0''	88°34'48.4''	40	NE	Sachung
Plot16	Alpine	4673	27°56'00.7''	88°34'50.1''	70	NE	Sachung
Plot17	Alpine	4647	27°55' 54.3''	88°34'49.9''	70	NE	Sachung
Plot18	Alpine	4627	27°55' 44.4''	88°34'48.0''	70	E	Jha-chu
Plot19	Alpine	4600	27°55' 40.2''	88°34'48.1''	20	NE	Dambachay
Plot20	Alpine	4556	27°55' 27.7''	88°34'34.4''	45	NW	Latha
Plot21	Alpine	4533	27°55' 22.7''	88°34'29.0''	70	NW	Latha

Plot22	Alpine	4515	27'55" 20.2	88'34"20.8	80	W	Membarung
Plot23	Alpine	4478	27'55" 10.9	88'34"16.5	30	W	Bamzay
Plot24	Alpine	4434	27'54" 56.75	88'34"04.6	30		Bamzay
Plot25	Alpine	4388	27'54" 56.76	88'33"54.8	30	E	Bamzay
Plot26	Alpine	4375	27'54" 48.2	88'33"54.9	70	E	Bamzay
Plot27	Alpine	4362	27'54" 40.7	88'33"42.4	60	N	Bamzay
Plot28	Alpine	4309	27'54" 24.9	88'33"21.4	60	NE	Bamzay
Plot29	Alpine	4279	27'54" 19.7	88'33"07.8	45	S	Bamzay
Plot30	Alpine	4234	27'54" 12.5	88'32"50.2	45	E	Bamzay
Plot31	Alpine	4152	27'54" 01.9	88'32"30.2	45	N	Bamzay
Plot32	Alpine	4123	27'53" 58.2	88'32"33.1	30	N	Thangu
Plot33	Alpine	4055	27'53" 55.4	88'32"28.8	30	NE	Thangu
Plot34	Alpine	4021	27'53" 54.8	88'32"21.9	45	NE	Thangu
Plot35	Alpine	3935	27'53" 50.3	88'32"19.1	45	NEE	Thangu
Plot36	Alpine	3859	27'53" 27.5	88'32"13.3	20	N	Thangu
Plot37	Alpine	3820	27'52" 56.2	88'32"14.9	20	SW	Rumchu
Plot38	Alpine	3810	27'52" 46.0	88'32"17.9	30	SW	Rumchu
Plot39	Alpine	3801	27'52" 35.0	88'32"21.6	30	SW	Rumchu
Plot40	Alpine	3756	27'52" 20.0	88'32"36.0	30	SW	Kalep
Plot41	Alpine	3654	27'52" 05.8	88'32"39.6	30	SW	Kalep
Plot42	Alpine	3655	27'51" 50.1	88'32"50.8	30	SW	Yathang

## FINDINGS

### INVENTORY (FLORA & FAUNA)

During the survey, a total of 42 sample plots were laid covering 0.42 ha area (Table & Figure). A general checklist of the floral species (Table 2) of the area (including the areas outside of the plots) were prepared. A total of 3 species of trees, 3 species of small tree / large shrubs, 19 species of shrubs/shrublets, 72 species of herbs, 11 species of fern and fern allies were recorded from the area during the present study (Table 2). The species recorded inside



the sample plots are marked with (\*) in the table. In the existing list of flora of the area (Sabita *et al.*, 2018, RBS III), four rare species were added during the present survey i.e., *Aconitum naviculare*, *Allium sp.*, *Codonopsis foetens* and *Gentiana elwesii* with few number of population (Photo plate 1).



**Photo plate 1: Added species in the existing list of flora of Thangu - Lashar**



*Aconitum naviculare*



*Allium sp.*



*Gentiana elwesii*



*Codonopsis sp.*

**Table 2: Floral species recorded in Thangu – Lashar valley and surrounding area, North Sikkim.**

Sl. No.	Name of Species	Family	Altitudinal range
	<b>TREES</b>		
1	* <i>Abies densa</i> Griff.	Pinaceae	2450-4000
2	<i>Acer pectinatum</i> wall. ex G.Nicholson	Aceraceae	2300-3800
3	* <i>Betula utilis</i> D.Don	Betulaceae	2500-3800
	<b>SMALL TREE / LARGE SHRUBS</b>		
1	* <i>Juniperus indica</i> Bert.	Cupressaceae	2600-5100
2	* <i>Lyonia ovalifolia</i> (Wallich) Drude	Ericaceae	300-3400
3	* <i>Salix</i> sp.	Salicaceae	ca. 3900
	<b>SHRUBS / SHRUBLETS</b>		
1	* <i>Berberis</i> sp.	Berberidaceae	-
2	* <i>Cassiope fastigiata</i> (Wall.) D.Don	Ericaceae	2800-4500
3	<i>Cassiope selaginoides</i> Hook. & Thoms.	Ericaceae	3000-5000
4	* <i>Cotoneaster microphyllus</i> Wall. ex Lindl.	Rosaceae	2000-5400
5	<i>Gaultheria nummularioides</i> D.Don	Ericaceae	2700-4500
6	<i>Gaultheria trichophylla</i> Royle	Ericaceae	2700-4500
7	* <i>Juniperus squamata</i> Buch.-Ham. ex D. Don	Cupressaceae	2000-4500
8	<i>Leptodermis</i> sp.	Rubiaceae	ca. 4400
9	* <i>Lonicera</i> sp.	Caprifoliaceae	-
10	* <i>Rhododendron anthopogon</i> D.Don	Ericaceae	3500-4500
11	* <i>Rhododendron campanulatum</i> D.Don subsp <i>aeruginosum</i> Hook.f.	Ericaceae	3000-4400
12	* <i>Rhododendron campanulatum</i> D.Don subsp sp. <i>campanulatum</i> D.Don	Ericaceae	Cupressaceae
13	* <i>Rhododendron campylocarpum</i> Hook. f.	Ericaceae	3000-3900
14	* <i>Rhododendron lepidotum</i> Wall. ex G.Don	Ericaceae	2500-5000
15	* <i>Rhododendron nivale</i> Hook.f.	Ericaceae	4500-5500
16	* <i>Rhododendron setosum</i> D.Don	Ericaceae	3500-5500
17	* <i>Ribes himalense</i> Royle ex Decne.	Grossulariaceae	1500-4200
18	* <i>Rosa sericea</i> Lindley	Rosaceae	2100-4500
19	* <i>Salix sikkimensis</i> Andersson	Salicaceae	3700-4500
	<b>HERBS</b>		
1	<i>Acanthocalyx nepalensis</i> (D. Don) M. J. Cannon	Morinaceae	2800-4500
2	* <i>Acomastylis elata</i> var. <i>elata</i> Wall. ex G.Don	Rosaceae	3500-5400
3	<i>Aconitum naviculare</i> (Bruhl) Stapf	Ranunculaceae	
4	* <i>Aconitum spicatum</i> Stapf.	Ranunculaceae	ca. 4000
5	* <i>Aletris pauciflora</i> (Klotzsch) Hand.-Mazz.	Liliaceae	3000-4300
6	<i>Allium</i> sp.	Amaryllidaceae	
7	* <i>Anaphalis</i> sp.	Asteraceae	-
8	* <i>Androsace selago</i> Hook. f. & Thomson ex Klatt	Primulaceae	3600-5000
9	* <i>Aorchis spathulata</i> (Lindl.) Verm.	Orchidaceae	2300-4300
10	* <i>Arenaria polytrichoides</i> Edgew	Caryophyllaceae	3500-5300

11	<i>Bistorta affinis</i> (D.Don) Greene	Polygonaceae	4000-4900
12	* <i>Caltha scaposa</i> Hook.f. & Thomson	Ranunculaceae	2800-4300
13	<i>Cardamine macrophylla</i> Willd.	Brassicaceae	3000-4200
14	* <i>Chesneya nubigena</i> (D.Don) Ali	Fabaceae	3600-5300
15	* <i>Spongiocarpella nubigena</i> (D.Don)Yakovlev	Fabaceae	3600-5200
16	<i>Clematis montana</i> Buch.-Ham. ex de Candolle.	Ranunculaceae	1000-4000
17	<i>Codonopsis foetens</i> Hook.f. & Thomson	Campanulaceae	3900-4600
18	* <i>Ephedra gerardiana</i> var. <i>sikkimensis</i> Stapf	Ephedraceae	ca. 4500
19	<i>Eriophyton wallichii</i> Benth.	Lamiaceae	2800-4800
20	* <i>Ephedra gerardiana</i> Wall. ex Stapf.	Ephedraceae	2500-5000
21	<i>Euphorbia stracheyi</i> Boissier	Euphorbiaceae	3000-4900
22	<i>Eutrema</i> sp.	Brassicaceae	-
23	* <i>Fragaria nubicola</i> (Lindl. ex Hook.f.) Lacaíta	Rosaceae	1800-3800
24	* <i>Fritillaria cirrhosa</i> D.Don	Liliaceae	3200-4600
25	<i>Gentiana elwesii</i> C.B.Clarke	Gentianaceae	Above 4000
26	<i>Juncus inflexus</i> L.	Juncaceae	1800-3200
27	<i>Juncus alpinoarticulatus</i> Chaix	Juncaceae	ca.3200
28	<i>Juncus himalensis</i> Klotzsch	Juncaceae	2400-4300
29	* <i>Juncus thomsonii</i> Buchenau	Juncaceae	2800-5000
30	* <i>Lloydia flavonutans</i> H.Hara	Liliaceae	3600-4500
31	<i>Meconopsis horridula</i> J. D. Hooker & Thomson	Papaveraceae	3600-5400
32	* <i>Meconopsis simplicifolia</i> (D. Don) Walp.	Papaveraceae	3300-5300
33	<i>Microula sikkimensis</i> (C. B. Clarke)	Boraginaceae	3000-4500
34	*Mosses	-	-
35	<i>Myricaria rosea</i> W.W.Smith	Tamaricaceae	2600-4800
36	<i>Nannoglottis hookeri</i> (C. B. Clarke ex J. D. Hooker)	Asteraceae	3400-4100
37	<i>Oxyria digyna</i> (L.) Hill	Polygonaceae	2400-5000
38	<i>Parnassia nubicola</i> Wall.ex Royle	Parnassiaceae	3000-4500
39	<i>Pedicularis longiflora</i> Rudolph	Scrophulariaceae	2100-5300
40	<i>Pedicularis megalantha</i> D.Don	Scrophulariaceae	2300-4300
41	* <i>Pedicularis oederi</i> Vahl	Scrophulariaceae	2600-5400
42	* <i>Persicaria wallichii</i> Greuter & Burdet	Polygonaceae	2500-3800
43	* <i>Phlomis rotata</i> Benth. ex Hook.f.	Lamiaceae	3800-6100
44	<i>Pleurospermum hookeri</i> C.B.Clarke	Apiaceae	2700-5400
45	* <i>Poa</i> sp.	Poaceae	-
46	<i>Podophyllum hexandrum</i> Royle	Berberidaceae	2400-4500
47	* <i>Polygonatum cirrhifolium</i> (Wallich) Royle	Asparagaceae	2000-4000
48	* <i>Potentilla peduncularis</i> D.Don	Rosaceae	3000-4500
49	<i>Potentilla arbuscula</i> D.Don	Rosaceae	2500-5500
50	* <i>Potentilla reptans</i> L.	Rosaceae	ca.3800
51	* <i>Primula calderiana</i> Balf. f. & R.E. Cooper	Primulaceae	3800-4700
52	* <i>Primula capitata</i> Hook.	Primulaceae	2800-4300
53	* <i>Primula concinna</i> Watt.	Primulaceae	4000-5000
54	* <i>Primula concinna</i> Watt. (White form)	Primulaceae	4000-5000
55	<i>Primula denticulata</i> Sm.	Primulaceae	1500-4500
56	* <i>Primula dickieana</i> watt	Primulaceae	4000-5000
57	* <i>Primula sikkimensis</i> Hook.	Primulaceae	3200-4500
58	* <i>Ranunculus hirtellus</i> Royle	Ranunculaceae	2800-5500



59	* <i>Ranunculus</i> sp. (Purple flower)	Ranunculaceae	
60	<i>Rheum noble</i> Hook.f. & Thoms.	Polygonaceae	3600-4500
61	<i>Rhodiola</i> sp.	Crassulaceae	ca. 4600
62	<i>Rhodiola himalensis</i> (D. Don) S. H. Fu	Crassulaceae	3300-4800
63	* <i>Rumax</i> sp.	Polygonaceae	ca. 4000
64	<i>Saxifraga brachypoda</i> D.Don	Saxifragaceae	3600-4800
65	<i>Saxifraga engleriana</i> Harry Smith	Saxifragaceae	4100-4700
66	<i>Saxifraga stenophylla</i> Royle	Saxifragaceae	3600-5000
67	* <i>Senecio raphanifolius</i> Wall. ex DC.	Asteraceae	2700-4400
68	<i>Taraxacum</i> sp.	Asteraceae	ca. 4200
69	* <i>Thermopsis barbata</i> Benth.	Fabaceae	2700-4500
70	<i>Triosetum himalaynum</i> Wall.	Caprifoliaceae	1800-4100
71	<i>Urtica hyperborea</i> Jacquem. ex Wedd.	Urticaceae	3000-5200
72	<i>Viola biflora</i> Linn.	Violaceae	2500-4300
<b>FERN AND FERN ALLIES</b>			
1	<i>Araistigiella hookeri</i> (T. Moore ex Bedd.) Fraser-Jenk	Davalliaceae	2700 – 3800
2	<i>Athyrium davidii</i> Christ.	Woodsiaceae	Above 3200
3	<i>Deparia subsimilis</i> (Christ.) Fraser-Jenk.	Woodsiaceae	3000 – 3600
4	<i>Dryopteris barbiger</i> (T. Moore ex Hook.) Kunze	Dryopteridaceae	Above 3500
5	<i>Dryopteris</i> sp.	Dryopteridaceae	ca.4000
6	<i>Dryopteris xanthomelas</i> (Christ) C. Chr.	Dryopteridaceae	3600 – 4300
7	<i>Lycopodium veithii</i> Christ Nagbeli	Lycopodiaceae	2600 – 4000
8	<i>Osmunda claytoniana</i> L	Osmundaceae	3000 – 4000
9	<i>Pichisermollodes erythrocarpa</i> Mett. ex Kuhn ( Fraser-Jenk)	Polypodiaceae	2600 – 3400
10	<i>Pichisermollodes fraser – jenkinsonii</i>	Polypodiaceae	2600 – 3400
11	<i>Polystichum</i> sp.	Dryopteridaceae	ca. 3800

## FAUNA

During the survey, the existence of a total of 23 bird species belonging to 3 order and 13 families were recorded. Similarly existence of a total of 10 mammalian species was recorded through direct and indirect evidences.

**Table: 1 Checklist of Avi-fauna of Thangu Valley and surrounding area in North Sikkim**

Sl. No	Common Name	Scientific Name	Family	Order	Evidence
1.	Blood pheasant	<i>Ithaginis cruentus</i>	Phasianidae	Galliformes	PC, DS
2.	Satyr tragopan	<i>Tragopan satyra</i>	Phasianidae	Galliformes	PC,
3.	Black-faced Laughingthrush	<i>Garrulax affinis</i>	Turdidae	Passeriformes	PC, DS
4.	Red-headed Bullfinch	<i>Pyrrhula erythrocephala</i>	Fringillidae	Passeriformes	PC
5.	Dark breasted Rosefinch	<i>Carpodacus nipalensis</i>	Fringillidae	Passeriformes	PC
6.	Plain Mountain Finch	<i>Leucosticte nemoricola</i>	Fringillidae	Passeriformes	PC

7.	White-capped Redstart	<i>Phoenicurus leucocephalus</i>	Muscicapidae	Passeriformes	PC
8.	Fire-tailed Sunbird	<i>Aethopyga ignicauda</i>	Nectariniidae	Passeriformes	PC
9.	House Crow	<i>Corvus splendens</i>	Corvidae	Passeriformes	PC, DS
10.	House Sparrow	<i>Passer domesticus</i>	Passeridae	Passeriformes	PC, DS
11.	Green-backed tit	<i>Parus monticolus</i>	Paridae	Passeriformes	PC
12.	Blue Whistling Thrush	<i>Myophonus caeruleus</i>	Muscicapidae	Passeriformes	PC, DS
13.	Common Myna	<i>Acridotheres tristis</i>	Sturnidae	Passeriformes	PC, DS
14.	Rock Dove	<i>Columba livia</i>	Columbidae	Columbiformes	PC, DS
15.	Oriental turtle dove	<i>Streptopelia orientalis</i>	Columbidae	Columbiformes	PC, DS
16.	Green Pigeon	<i>Treron</i>	Columbidae	Columbiformes	PC, DS
17.	Kalij Pheasant	<i>Lophura leucomelanos</i>	Phasianidae	Galliformes	PC
18.	Ashy Throated Warbler	<i>Phylloscopus maculipennis</i>	Sylviidae	Passeriformes	PC
19.	Red Billed Chough	<i>Pyrrhocorax pyrrhocorax</i>	Corvidae	Passeriformes	PC
20.	Snow Pigeon	<i>Columba leuconota</i>	Columbidae	Columbiformes	PC
21.	Long tailed thrush	<i>Zoothera dixonii</i>	Turdidae	Passeriformes	DS
22.	Golden naped Finch	<i>Pyrrhoplectes epaulette</i>	Fringillidae	Passeriformes	DS
23.	Whiskered Yuhina	<i>Yuhina flavicollis</i>	Zosteropidae	Passeriformes	DS

PC: Photo Capture, DS: Direct Sighting

**Table: 2 Checklist of mamalian species of Thangu Valley and surrounding areas in North Sikkim**

Sl. No.	Common Name	Scientific Name	Family	Evidence <sup>1</sup>
1.	Musk Deer (Kasturi mriga)	<i>Moschus chrysogaster</i>	Moschidae	SI
2.	Red fox	<i>Vulpes vulpes</i>	Canidae	S
3.	Kiang	<i>Equus kiang</i>	Equidae	SI
4.	Tibetan Sand Fox	<i>Vulpes ferrilata</i>	Canidae	DS
5.	Himalayan Marmot	<i>Marmota himalayana</i>	Sciuridae	SI
6.	Himalayan Black Bear	<i>Ursus thibetanus</i>		FS
7.	Yellow-throated Marten (Malsapra)	<i>Martes flavigula</i>	Mustelidae	SI, S
8.	Pika	<i>Ochotona sp.</i>	Ochotonidae	DS
9.	Serow (Thar)	<i>Capricornis thar</i>	Bovidae	HM, P
10.	Wild dog	<i>Cuon alpinus</i>	Canidae	SI

<sup>1</sup>SI: Secondary Information, DS: Direct Sighting, FS: Foraging sign, HM: Hoof mark, P: Pellet, S: Scat <sup>2</sup>EN: Endangered, LC: Least concern, VU: Vulnerable, NT: Near threatened

## CONCLUSION AND RECOMMENDATIONS

The area was explored for inventory and assessment of biodiversity during 2017 and present survey (2019) was the revisit to observe whether changes occur in the biodiversity and their habitat in the area. The area is highly impacted by the natural as well as anthropogenic disturbance which needs immediate attention. Grazing, by yak, cow and horse though

observed high in the area, which may not be an immediate threat but due care should be taken so that it does not exceed the carrying capacity and lead to domestic cattle – wild animal conflict. Increase in feral dog population is emerging as a serious threat to the wildlife; hence the problem of feral dog needs to be resolved at the earliest. Other existing threats to the biodiversity of the area observed during the study are construction of roadways and army personnel garrisoned. The deforestation and unsustainable extraction of plants specially *Abies densa* and *Rhododendron anthopogon*, *Juniperus* sp., *Rheum nobile* for firewood, medicine and incense and so on, by the local inhabitants as well as the army are the general disturbances resulted in the building up considerable pressure on the survival of the species.



Other major threats are obviously, the effect of drastic changes in climate. The sudden changes in the environmental parameters including strange weather such as unusual rainfall, hailstorm etc. effects the vegetation greatly. In our observation, the blooming patterns of *Rhododendrons* of sub alpine and alpine areas have been changed and has observe the late initiation of flowering in case of some of the species like *R. niveum*, *R. campanulatum sub sp aeroginosum*, *R. nivale*, *R. lanatum* etc.

In the context of the change in population of the species within these two years 2017-19), there was no change in the population of available trees (below Thangu), shrubs, shrublets and herbs, except one globally endangered species namely *Aconitum spicatum*, the population of which, the population has been increased in terms of average percent cover, from 1.07 % to 2.63 %, which is due to massive plantation of the species.





**Plantation sites of *Aconitum spicatum* at Thangu valley**





# INVENTORY AND MONITORING OF BIODIVERSITY OF BARSEY RHODODENDRON SANCTUARY, WEST SIKKIM

*Sabita Dahal & Meena Tamang*



## STUDY AREA

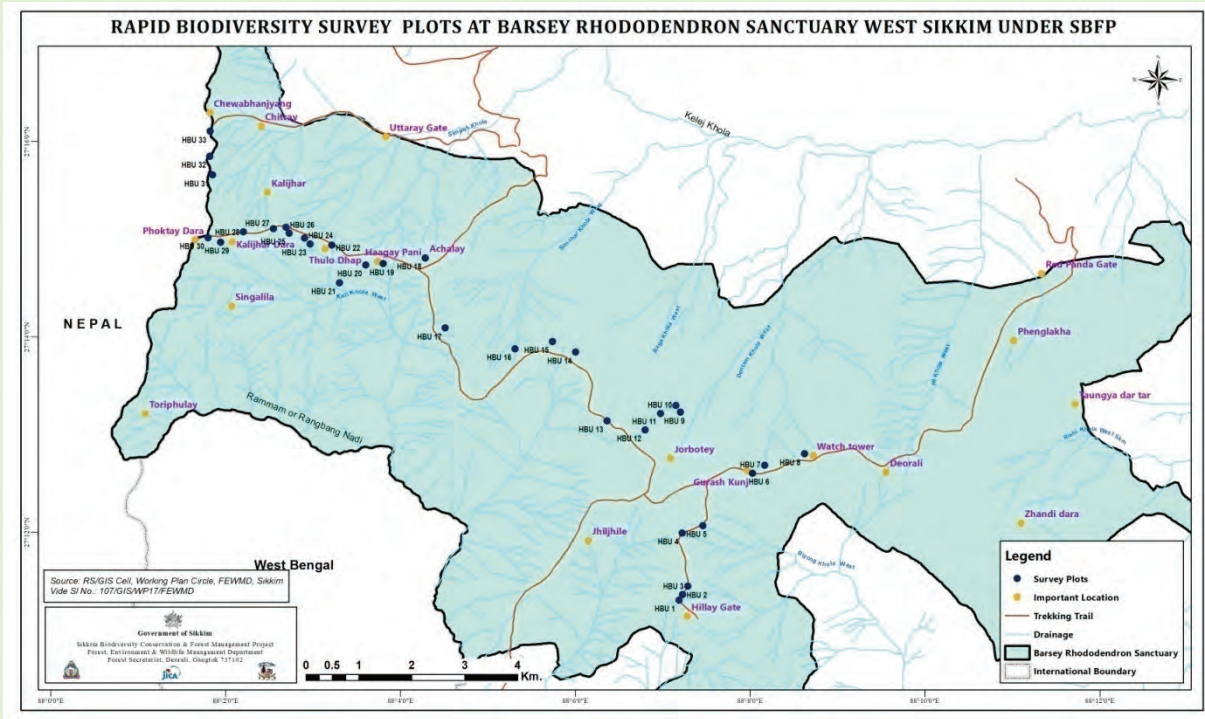
A field trip for conducting monitoring and evaluation of biodiversity of Barsey Rhododendron Sanctuary (re-visit) were conducted after two years of Rapid Biodiversity Survey especially to observe and evaluate changes on biodiversity. The survey were done covering a sampling path along Hillay – Phoktay dara – Chewabhyanjang sampling path during May 2019 and October 2019 (Monsoon & post monsoon).

The forest type of the area is represented by Temperate Rhododendron Mixed Forest forest, Temperate Coniferous forest, Subalpine forest and alpine. The elevation range covered during the survey was from 2200m (Hillay) to 3610m (Phoktey Dara) which is represented by Figure 1. The slope angle of the area ranged between stiff (70 degree) to mild (25 degree) slope and is facing towards N, NE, NW, E and S aspect as showed in table 1.

Forest being temperate to alpine trees is the most predominant taxa in the lower altitudes, followed by herbs, shrubs and shrublets, ferns, climbers and epiphytes. The area

constitutes a diverse habitat for both flora and fauna of the temperate to alpine belt. The area is highly dominated with the trees and small trees species namely *Rhododendron arboreum*, *Rhododendron barbatum*, *Taxus wallachiana*, *Rhododendron falconeri*, *Rhododendron griffithianum*, *Rhododendron hodgsonii*, *Acer campbellii*, *Acer palmatum*, *Lithocarpus pachyphyllus*, *Lyoniao valifolia*, *Magnolia campbellii*, *Magnolia doltsopa*, *Tsuga dumosa*, *Eurya acuminata*, *Symplocos lucida*. In the higher altitude areas, above Deonigali Dhap, the dominant species observed were *Rhododendron falconeri*, *Rhododendron barbatum*, *Betula utilis*, *Acer pectinatum* and *Yushania maling*. In the entire area of Deonigali Dhap (2700-2900m) *Sinarundinaria macrophylla* (Deonigalo) was observed as the highly dominating species, which is the only natural habitat of *Sinarundinaria macrophylla* (Figure 2). Common shrub species recorded from the area are *Rhododendron campanulatum*, *Rhododendron dalhousieae*, *Rhododendron lindleyi*, *Rhododendron lepidotum*, *Rubus ellipticus*, *Rubus niveus*, *Rubus paniculatus*, *Viburnum erubescens*, *Dichroa febrifuga*, *Maesa chisia*, *Oxyspora paniculata* etc. Diversity of the ground covering herbs species in the area recorded high, but in terms of density, in term of the percentage of ground cover, was comparatively less. Along the upper region of the forest, *Yushania maling* (Malingo) appeared as highly dominant ground covering species. *Yushania maling* is not a tree species, but a bamboo species (grass family); however, the species cannot be ignored while conducting vegetation assessment because it is the highly dominating species in the upper temperate forest with an individual plant density per hectare of 55.263. For such species, the number of clumps was counted and estimated its population in terms of individual plant density per hectare. In addition, the area also provide diverse habitat for the faunal species.





**Figure 2:** Barsey Rhododendron Sanctuary showing sampling path From Hilay – Phoktay Dara – Chewabhanjyang in West Sikkim.



**Figure 3:** Deonigali Dhap, the only natural habitat of *Sinarundinaria macrophylla* (Deonigalo) in Sikkim

## METHODOLOGY

Monitoring and evaluation of biodiversity were done using Rapid Biodiversity Survey Techniques (RBST). Prior to field work, Previous RBS report of the area along with other relevant literatures were scrutinised to have an idea about the biodiversity of the area. The checklist of the species (both flora and fauna) was prepared and was taken to the field to confirm their presence in the study area. During the field work, general listing of all the species occurring in the area (both flora and fauna) were made to have fair knowledge on the biodiversity of the area.

In the field, the quantitative as well as qualitative data on floral biodiversity was recorded using a Standard Quadrat Sampling method, wherein, a random plot of 10m x 10m were established which was followed by lying of plot after every 0.5 to 0.6 km approximate distance. Within the plot, all the tree species were listed and the individual tree width CBH > 30 cm (1.3 m above the ground) was measured. Within the mother plot, a quadrat of 5m x 5m was laid in the centre to record the number of saplings present; the same quadrat was used to record the percent cover of the shrub species. 5 number of 1m x 1m quadrat were laid; 2 at the alternate corners of the 5m x 5m quadrat and 1 at the centre for recording the percent cover of the herb species; the same quadrat was used to record the number of seedlings. General listing of all the species (flora) encountered along the sampling plots as well as outside was also done to have fair idea on the species availability in the area. Parameters such as coordinates and altitude of each sample plots were recorded using hand held GPS; slope aspect and slope angle of each plots were also recorded.





### **Full bloom of Rhododendrons at Barsey Rhododendron Sanctuary**

In case of trees, recorded data were analyzed for density, frequency, abundance, basal area etc. Importance value index (IVI) was determined as the sum of percentage density and percentage basal area. Species diversity for each plot was determined with the Shannon and Wiener information function, which reads as  $H' = -\sum(n_i/N) \log_2 n_i/N$ , where 'n<sub>i</sub>' represents total number of individuals of particular species, and 'N' represents total number of individuals of all species. Species richness was calculated using Margalef's index as  $I = (S-1)/\ln(N)$ , where 'S'=the number of species in the sample and 'N'=the total number of individuals in the sample. Species evenness was determined by Shannon index of evenness as,  $E = H/\ln(S)$  where 'H'=Shannon' Index of diversity and 'S'=number of species in the sample. Concentration of dominance was measured by Simpson's Index, which reads as,  $D = \sum(n_i/N)^2$  where, 'n<sub>i</sub>' represents total number of individuals of particular species and 'N' represents total number of individuals of all species. In case of shrubs and herbs, populations were calculated in terms of Average Percent Cover.

To record the faunal element occur in the area, trail sampling (walking through the trail) and sign surveys (records of digging sign, foraging sign, hoof mark, etc.) were made. During the survey, direct evidences like call sound and indirect evidences like feather, pellets, scats, droppings etc. were recorded. Photo capture was also done, depending upon the feasibility.

Then the observations and outcomes (both qualitative and quantitative) were compared with the published report of previous Rapid Biodiversity Survey of the area and other available literatures and interpreted.



**Table 1:** Site characteristics of the survey site along Hillay – Phoktay dara – Chewabhyanjang sampling path at Barsey Rhododendron Sanctuary, West Sikkim.

Site Code	Forest Type	Altitude (m)	GPS Coordinate		Slope Angle	Slope Aspect	Canopy Cover (%)	Location
			Latitude	Longitude				
Plot 1	Mixed temperate	2737	27°11'10.0"	88°07'18.0"	70	N	30	Hilley
Plot 2	Mixed temperate	2774	27°11'18.4"	88°07'14.2"	80	NE	20	Hilley
Plot 3	Mixed temperate	2797	27°11'23.5"	88°07'17.7"	80	NE	10	Hilley
Plot 4	Mixed temperate	2842	27°11'56.09"	88°07'14.4"	50	E	20	Hilley
Plot 5	Mixed temperate	2811	27°12'20.0"	88°07'28.0"	60	NW	10	Hilley
Plot 6	Mixed temperate	2865	27°12'32.0"	88°07'50.0"	10	E	25	Hilley
Plot 7	Mixed temperate	2822	27°12'17.0"	88°07'26.0"	10	SE	30	Barsey
Plot 8	Mixed temperate	2797	27°12'44.1"	88°08'38.7"	40	NE	15	Barsey
Plot 9	Mixed temperate	2834	27°12'37.0"	88°08'03.0"	70	NE	20	Barsey
Plot 10	Mixed temperate	2845	27°13'10.3"	88°07'13.8"	25	E	45	Barsey
Plot 11	Mixed temperate	2871	27°13'9.7"	88°07'0.1"	40	NE	10	Barsey
Plot 12	Mixed temperate	2826	27°12'59.7"	88°06'49.5"	40	N	10	Lasuney
Plot 13	Mixed temperate	2852.8	27°12'56.0"	88°06'45.0"	35	E	60	Above Lasuney
Plot 14	Mixed temperate	2808	27°13'29.0"	88°06'08.0"	60	SE	0	Below Deonigalo Dhaap
Plot 15	Mixed temperate	2787	27°13'55.0"	88°05'32.0"	45	E	60	Deonigalo Dhaap
Plot 16	Mixed temperate	2813	27°13'49.0"	88°04'51.0"	10	E	40	Above Deonigalo Dhaap
Plot 17	Mixed temperate	2872	27°13'50.2"	88°04'32.9"	mild	NE	10	Above Duck Pokhari

Plot 18	Mixed temperate	2829	27°14'46.0"	88°04'11.0"	mild	NE	0	Achallay
Plot 19	Mixed temperate	2885	27°14'42.0"	88°03'40.0"	30	NE	20	Above Achallay
Plot 20	Mixed temperate	2939.9	27°14'45.0"	88°03'28.0"	15	NE	20	
Plot 21	Mixed temperate	2916	27°14'50.0"	88°03'22.0"	10	NE	0	
Plot 22	Mixed temperate	2877	27°14'50.0"	88°03'06.6"	mild	NE	10	ThuloDhap
Plot 23	Mixed temperate	3002	27°14'55.6"	88°03'0.5"	40	NE	30	Above ThuloDhap
Plot 24	Mixed temperate	3068	27°14'59.7"	88°02'54.2"	30	NE	20	
Plot 25	Mixed temperate	3177	27°15'03.6"	88°02'45.7"	mild	NE	20	
Plot 26	Mixed temperate	3250	27°15'07.8"	88°02'43.2"	60	NE	35	
Plot 27	Mixed temperate	3352	27°15'04.9"	88°02'34.2"	10	NE	0	Chipchipey
Plot 28	Sub-Alpine	3412	27°15'3.5"	88°02'14.8"	90	SW	0	Kalijhar
Plot 29	Sub-Alpine	3509	27°14'57.2"	88°01'59.9"	90	NE	0	Above Kalijhar
Plot 30	Alpine	3610	27°15'10.0"	88°01'50.5"	mild	NE	0	PhokteyDara
Plot 31	Mixed temperate	3251	27°15'38.5"	88°01'53.9"	60	NE	10	
Plot 32	Mixed temperate	3157	27°15'50.10"	88°01'52.3"	45	E	15	Before Chewa-bhanjyang
Plot 33	Mixed temperate	3119	27°16'5.8"	88°01'52.16"	25	S	10	Chewa-bhanjyang

## FINDINGS AND DISCUSSION

### INVENTORY (FLORA & FAUNA)

During the survey, a total of 33 plots were laid covering 0.33 ha area (Table & Figure). A general checklist of the floral species (Table) of the area (including the areas outside of the plots) were prepared. A total of 22 species of trees, 29 species of shrubs/scrubs, 64 species of herbs, 7

species of climbers, 4 species of epiphytes and 2 species of bamboo were recorded from the area during the present study (Table 2). In the existing list of flora of the area (Sanjyoti *et al.*, 2018, RBS III), *Taxus wallichiana* (Dhengre Salla) was not reported from the sanctuary, which has been recorded during the recent survey with good number of population and good regeneration. In case of shrubs or shrublets, three numbers of species has been added during the present survey i.e., *Rhododendron lindleyi*, *Rhododendron cinnabarinum* and *Viburnum grandiflorum*. One important climber species naturally grown in the area with good population i.e., *Actinidia deliciosa* (Wild Kiwi) was also missed in the previous report, which has been recorded in the present survey. In case of herbs, 14 species were added during the present survey namely *Aconitum palmatum*, *Aconitum sp.*, *Anaphalis busua*, *Anaphalis hookeri*, *Anemone sp.*, *Anemone flavum*, *Artemesia sp.*, *Astilbe rivularis*, *Panax bipinnatifidus*, *Polygonatum vacciniifolium*, *Primula capitata*, *Juncus himalensis*, *Juncus thomsonii*, *Juncus inflexus*.

**Photo plate I: Added tree/ shrubs / climber species in the existing list of flora of Barsey**

**Rhododendron Sanctuary**



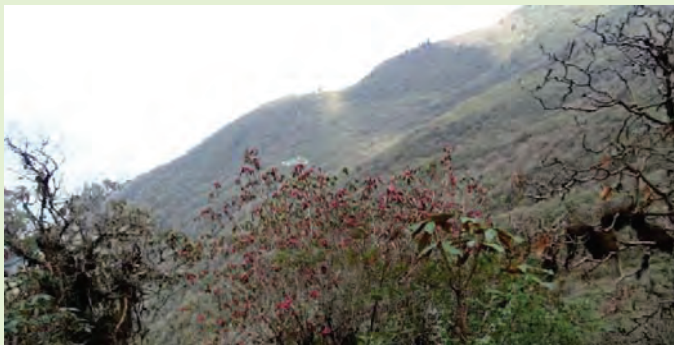
***Taxus wallichiana* and its regeneration**

**Photo Plate 1 Contd...**





*Actinidia deliciosa* (Kiwi )



*Rhododendron cinnabarinum*



*Rhododendron lindleyi* and its natural habitat



## *Viburnum grandiflorum* and its natural habitat

**Table 2: List of floral species recorded in Barsey Rhododendron Sanctuary**

S. No	Botanical Name	Common Name	Local Name	Family	Altitudinal Distribution (m asl)	IUCN/ Regional Status
<b>Trees</b>						
1	<i>Abies densa</i> Griffith. ex Parker	Silver Fir	Gobrey Salla	Pinaceae	2800 – 3700	LC
2	<i>Acer campbellii</i> Hook. & Thom. ex Hiern	Campbell's Maple	Kapasay	Aceraceae	1800 – 2700	NA
3	<i>Acer palmatum</i>	Palmate Maple	Kapasay	Aceraceae	2500 – 3000	NA
4	<i>Acer pectinatum</i> Wall. ex Nicholson	Maple	Lekh Kapasay	Aceraceae	2300 – 3700	NA
5	<i>Antidesma montanum</i> Blume		Lek Bilauney	Phyllanthaceae		NA
6	<i>Betula utilis</i> Don	Himalayan Birch	Bhojpatra	Betulaceae	2500 – 3800	LC
7	<i>Lithocarpus pachyphylla</i> (Kurtz.) Rehder	Thick-leaved Oak	Sungurey Katus, Bante	Fagaceae	1800 – 2700	NA
8	<i>Lyonia ovalifolia</i>	Oval-leaved Lyonia	Angeri	Ericaceae	1500 – 3000	NA
9	<i>Machilus</i> sp.		Kawlo	Lauraceae	1500 – 2100	NA
10	<i>Maddenia himalaica</i> Hook. f. & Thom.			Rosaceae	2400 – 3000	NA
11	<i>Magnolia campbellii</i> Hook. f. & Thom.	Campbell's Magnolia	Ghogeyp Champ	Magnoliaceae	2400 – 3100	LC
11	<i>Magnolia doltsopa</i> (Buch.-Ham. ex DC.) Figlar	Doltsopa	Rani Champ	Magnoliaceae	2100 – 2500	NA
12	<i>Prunus</i> sp.					
13	<i>Rhododendron arboreum</i> (CB Clarke) Ridley.	Arborescent Rhododendron	Lali Gurans	Ericaceae	1700 – 3400	IUCN: NA; Sikkim: VUL <sup>(5)</sup>
14	<i>Rhododendron barbatum</i> Wall. ex G. Don	Bristly Rhododendron	LalChimal	Ericaceae	3000 – 3700	IUCN: NA; Sikkim: VUL
15	<i>Rhododendron falconeri</i> Hook. f	Dr. Falconer's Rhododendron	Korlinga	Ericaceae	2700 – 3000	IUCN: NA; Sikkim: Threatened
16	<i>Rhododendron grande</i> Wight	Large Silvery Rhododendron	Patle Korlinga	Ericaceae	2000 – 3000	IUCN: NA; Sikkim: Threatened
17	<i>Rhododendron griffithianum</i> Wight	Lord Auckland's Rhododendron	Seto Chimal	Ericaceae	1800 – 3200	IUCN: NA; Sikkim: Out of danger
18	<i>Rhododendron hodgsonii</i> Hook. f.	Hodgson's Rhododendron	Khorlinga	Ericaceae	3000 – 4000	IUCN: NA; Sikkim: Out of danger
19	<i>Sorbus</i> sp.		Lekpasi	Rosaceae	2700 – 5400	NA
20	<i>Symplocos lucida</i>		Kharanay	Symplocaceae	1900 – 2500	NA
21	<i>Tsuga dumosa</i> (D. Don) Eichler	Himalayan Hemlock	Tengre Salla	Pinaceae	2500 – 3000	LC
22	<i>Taxus wallachiana</i> Zucc.	Himalayan Yew	Dhengre Salla	Taxaceae	1800-3400	EN

Shrubs/Scrubs						
1	<i>Acanthopanax cissifolius</i> (Griff. ex C.B.Clarke) Harms	Grape-Leaf Eleuthero		Araliaceae	2500 – 3600	NA
2	<i>Aconogonummolle</i> (D. Don) H. Hara	Sikkim Knotweed	Thotne	Polygonaceae	1300 – 3200	NA
3	<i>Alstonia</i> sp.			Apocynaceae		
4	<i>Berberis insignis</i> Hook. F. &Thoms.		Chutro	Berberidaceae	2000 – 3400	NA
5	<i>Berberis smucrifolia</i> Ahrendt	Box-leaved Barberry		Berberidaceae		
6	<i>Cotoneaster microphyllus</i> Lindley	Rockspray Cotoneaster		Rosaceae	2400 – 4000	NA
7	<i>Daphne cannabina</i> Lour.	Indian Paper Plant	Kalo argaley, Lokta	Thymelaeaceae		
8	<i>Elatostema platyphyllum</i> Wedd.		Sano Gagleto	Urticaceae	700 – 1900	NA
9	<i>Enkianthus deflexus</i> (Griff.) C.K. Schneid.	Himalayan Red Bells, Himalayan Enkianthus	Rato Angeri	Ericaceae	2500 – 3300	NA
10	<i>Gaultheria nummularioides</i> D.Don	Coinwort Snowberry	Kaali Gedi	Ericaceae	2100 – 4100	NA
11	<i>Gaultheria trichophylla</i> Royle	Himalayan Snowberry	Kaali Gedi	Ericaceae	2700 – 4500	NA
12	<i>Ilex intricata</i> J.D.Hooker			Aquifoliaceae	3000-4700	NA
13	<i>Mahonianapaulensis</i> DC.	Nepal Mahonia, Indian barberry	Jamane Mandro	Berberidaceae	1200 – 3000	NA
14	<i>Piptanthus nepalensis</i> (Hook.) D. Don	Evergreen Laburnum		Fabaceae	2100 – 3600	NA
15	<i>Rhododendron campanulatum</i> D.Don	Bell-flowered Rhododendron	Nilo Chimal	Ericaceae	3000 – 4500	IUCN : NA; Sikkim: Threatened
16	<i>Rhododendron cinnabarinum</i> Hook.f.	Cinnabar Rhododendron	Sanu Chimal	Ericaceae	2700-4000	IUCN : NA; Sikkim: Out of danger
17	<i>Rhododendron dalhousiae</i> Hook. f. & Thom.	Lady Dalhousie's Rhododendron	Lahare Chimal	Ericaceae	2000 – 2600	IUCN : NA; Sikkim: Out of danger
18	<i>Rhododendron lepidotum</i> Wall. ex G. Don	Scaly Rhododendron	Bhale Sunpate	Ericaceae	2500 – 5000	IUCN : NA; Sikkim: Out of danger
19	<i>Rhododendron lindleyi</i> T.Moore		Lahare Chimal	Ericaceae	2700-3100	IUCN : NA; Sikkim: Rare
20	<i>Ribes</i> sp.			Grossulariaceae		
21	<i>Rosa sericea</i> Lindl.	Silky Rose	Bhotey Gulab	Rosaceae	2100 – 4500	NA
22	<i>Rubus ellipticus</i> Sm.	Yellow Himalayan Raspberry	Ainselu	Rosaceae	1700 – 2300	NA



23	<i>Rubusnepalensis</i> (Hook.f.) Kuntze	Nepalese Raspberry	Bhui Ainselu	Rosaceae	2100 – 3200	NA
24	<i>Rubusniveus</i> Thunb.	Mysore Raspberry	Ainselu	Rosaceae	500 – 2800	NA
25	<i>Spiraea arcuata</i>	Arching Spirea	Panda, Pans	Rosaceae	3000 – 4200	NA
26	<i>Spiraea bella</i> Sims.	Pretty Spirea, Himalayan Spirea		Rosaceae	2100 – 3600	NA
27	<i>Viburnum erubescens</i> Wall.	Reddish Viburnum	Asare	Adoxaceae	1500 – 2700	NA
28	<i>Viburnum grandiflorum</i>	Grand Viburnum	Asare	Adoxaceae	2700-3600	NA
29	<i>Viburnum nervosum</i> D. Don		Asare Lekh	Adoxaceae	2600 – 3500	NA
<b>Herbs</b>						
1	<i>Aconitum palmatum</i>	Indian aconite	Bikhma	Ranunculaceae	ca. 3100	VU
2	<i>Aconitum</i> sp.	Indian aconite	Bikhma	Ranunculaceae		CR
3	<i>Acanthus</i> sp.			Acanthaceae		
4	<i>Ainsliaea aptera</i> DC.	Wingless Ainsliaea		Asteraceae	1200 – 3600	NA
5	<i>Ajuga lobata</i> D. Don			Lamiaceae	1500 – 3300	NA
6	<i>Amorphophallus</i> sp.			Araceae	1400 – 2700	
7	<i>Anaphalis busua</i> (Buch.-Ham.ex D. Don) DC		Bukiful	Asteraceae	1800-3600	
8	<i>Anaphalis hookeri</i> Clarke ex Hook.f.		Bukiful	Asteraceae	3000-3700	
9	<i>Anemone</i> sp.			Ranunculaceae	ca. 3413	
10	<i>Anemone flavum</i> (Forssk.) Schott.		Banko/ Larua	Araceae	1800-3600	
11	<i>Arisaema consanguineum</i> Schott	Jack in the Pulpit		Araceae	2200 – 2700	NA
12						
13	<i>Arisaema griffithii</i> Schott	Griffith's Cobra Lily	Lauro/Banko	Araceae	2400 – 3600	NA
14	<i>Arisaemanepenthoides</i> (Wall.) Mart.	Cobra Lily	Tuwa	Araceae	2000 – 3300	NA
15	<i>Arisaema speciosum</i> (Wall.) Mart.	Himalayan Giant Cobra Lily	Larua/Banko	Araceae	2400 – 2800	NA
16	<i>Arisaema</i> sp.			Araceae		
17	<i>Artemesia</i> sp.		Titepati		ca. 2300	
18	<i>Astilbe rivularis</i> Buch.-Ham.ex D. Don		Buri Okhati	Saxifragaceae	1500-3200	
19	<i>Carex</i> sp.			Cyperaceae		
20	<i>Centell asiatica</i> (L.) Urb.	Indian Pennywort	Golpatta	Apiaceae	500 – 2100	LC
21	<i>Cirsium</i> sp.			Asteraceae		
22	<i>Clintonia udensis</i> Trautv. & C.A. Mey.	Bead Lily		Liliaceae	1600 – 4000	NA
23	<i>Conium maculatum</i> L.	Poison Hemlock		Apiaceae		NA
24	<i>Fragaria nubicola</i> Lindl.	Himalayan Strawberry		Rosaceae	2000 – 3600	NA
25	<i>Gentiana pedicellata</i> (D. Don) Wall	Purple Stalked Gentian		Gentianaceae	2100 – 3400	NA
26	<i>Gentiana</i> sp.			Gentianaceae		

27	<i>Geranium</i> sp.			Geraniaceae		
28	<i>Halenia</i> sp.			Gentianaceae	Upto 4100	NA
29	<i>Hemiphragma heterophyllum</i> Wall.	Nash Jhar	Lalgeri	Scrophulariaceae	1800 – 3600	NA
30	<i>Heracleum wallichii</i> DC		Chimping	Apiaceae	3600 – 4100	NA
31	<i>Hypericum</i> sp.		Urilo	Hypericaceae		
32	<i>Impatiens</i> sp.			Balsaminaceae		
33	<i>Juncus himalensis</i> Klotzsch			Juncaceae		
34	<i>Juncus thomsonii</i> buchenau			Juncaceae	3200-4000	
35	<i>Juncus inflexus</i> L.			Juncaceae	1800-2300	
36	<i>Lecanthu peduncularis</i> (Wall. ex Royle) Wedd.	Stalked Dischead	Gakaleti, GantheGolia, Goliko	Urticaceae	1200 – 3200	NA
37	<i>Ligularia</i> sp.		BarseyJhar	Asteraceae		
38	<i>Lycopodium</i> sp.			Lycopodiaceae		
39	<i>Meconopsis paniculata</i> (D. Don) Prain	Panicled Yellow Poppy	Gyashur	Papaveraceae	3000 – 4100	NA
40	<i>Meconopsis</i> sp.			Papaveraceae		
41	<i>Mimulus nepalensis</i> Benth.	Nepal Monkey Flower		Scrophulariaceae	1200 – 3000	NA
42	<i>Nepeta floccosa</i> Benth.			Lamiaceae	2700-4400	
	<i>Oxalis corniculata</i> L.	Creeping Wood Sorrel	AmiloJhar	Oxalidaceae	250 – 2450	NA
43	<i>Oxalis</i> sp.			Oxalidaceae		
44	<i>Panax bipinnatifidus</i> Seem		Zinsing	Araliaceae		VU
45	<i>Paris polyphylla</i> Sm.	Himalayan Paris	Satuwa	Melanthiaceae	2000 – 3000	NA
46	<i>Pedicularis</i> sp.			Orobanchaceae		
47	<i>Persicaria capitata</i> (Buch.-Ham. ex D.Don) H.Gross	Pink Knotweed	Ratnaulo	Polygonaceae	600 – 2400	NA
48	<i>Persicaria runcinata</i> (Buch.-Ham. ex D. Don) H. Gross	Lobed Leaf Knotweed	Ratnaulo	Polygonaceae	1600 – 3800	
49	<i>Polygonatum vacciniifolium</i> Wall.ex Meisner		Mahameda	Polygonaceae	3000-4200	CR
50	<i>Potentilla peduncularis</i> D. Don	East Himalayan Cinquefoil	Nagabhya	Rosaceae	3000 – 4500	NA
51	<i>Primula capitata</i> Hook.			Primulaceae	2800-4200	
53	<i>Primula gracilipes</i> Craib			Primulaceae	3500 – 4000	NA
54	<i>Rumex nepalensis</i> Spreng.	Nepal Dock	Halhalley	Polygonaceae	1200 – 4300	NA
55	<i>Sambucus</i> sp.			Adoxaceae		
56	<i>Streptopus simplex</i>	Simple Twisted Stalk		Liliaceae	2400 – 4000	NA
57	<i>Swertia bimaculata</i> (Siebold&Zucc.) Hook. f. & Thomson ex C.B. Clarke	Double-Spotted Swertia	BhaleyChirowto	Gentianaceae	200 – 3000	NA
59	<i>Swertia chirayita</i> (Roxb.) Buch.-Ham. ex C.B. Clarke	Chirayita	Chiraita	Gentianaceae	1500 – 2500	NA

60	<i>Taraxacum officinale</i>	Common Dandelion		Asteraceae	3350 – 5500	NA
61	<i>Thalictrum foliolosum</i> DC.	Leafy Meadow-Rue		Ranunculaceae	1300 – 3400	NA
62	<i>Trillium govanianum</i> Wall. ex D.Don	Himalayan Trillium		Melanthiaceae	2700 – 4000	NA
63	<i>Viola serpens</i> Wall. exGing.			Violaceae	1400 – 3500	NA
64	<i>Viola pilosa</i> Blume	Smooth Leaf White Violet	Ghatteghans	Violaceae	1200 – 3000	NA
<b>Epiphytes</b>						
1	<i>Agapetes serpens</i> (Wight) Sleumer	Himalayan Lantern, Creeping Agapetes	Khursani	Ericaceae	1720 – 2130	NA
2	<i>Gastrochilus calceolaris</i> (Buch.-Ham. ex Sm.) D.Don	Shoe-shaped Gastrochilus		Orchidaceae	1500 – 2200	CR
3	<i>Vaccinium nummularia</i> Hook. fil. &Thoms. ex. C. B. Cl.	Coin Whortleberry		Ericaceae	2400 – 4000	NA
4	<i>Vaccinium retusum</i> (Griff.) Hook. fil. ex C. B. Cl.	Himalayan Blueberry	Mussi kane	Ericaceae	2130 – 3050	NA
<b>Climbers</b>						
1	<i>Actinidia deliciosa</i> (A.Chev.) C.F.Liang & A.R.Ferguson	Wild Kiwi, Kiwi fruit		Actinidiaceae	2500-2800	
2	<i>Clematis acuminata</i> DC.		Ransag	Ranunculaceae	500 – 2400	NA
3	<i>Clematis Montana</i> Buch.-Ham. ex DC.	Anemone clematis, Indian virgin's bower	JungeLaharo	Ranunculaceae	2100 – 4100	NA
4	<i>Crawfordia speciosa</i> Wall.	Showy Gentian Vine		Gentianaceae	2400 – 3000	NA
5	<i>Holboellia latifolia</i> Wall.	Sausage Vine, Holboellia	Bagul, Guphala, Malkati	Berberidaceae	1500 – 4000	NA
6	<i>Rubia manjith</i> Roxb. ex Fleming	Indian Madder, Manjith	Majitho	Rubiaceae	700 – 3600	NA
7	<i>Smilax</i> sp.			Smilacaceae		
<b>Bamboo</b>						
1	<i>Yushania maling</i>		Maling	Poaceae	2737-3002	
2	<i>Sinarundinaria macrophylla</i>		Deonigalo	Poaceae	1800 – 3300	Rare in Sikki m
<b>Note:</b> NA, Not Assessed; CR, Critically Endangered; LC, Least Concern.						

## FAUNA

During the biodiversity survey in Barsey Rhododendron Sanctuary, the existence of a total of 34 avi-fauna species, 17 fauna species and 3 butterflies' species were recorded through direct sightings and indirect evidences, which are listed in table.



**Table 3: List of faunal and avi-faunal species recorded along the Barsey Rhododendron Sanctuary.**

S.No	Scientific Name	Common Name	Local Name	Family	Evidences	Altitudinal Range (m)	Conservation Status
<b>Avi-fauna</b>							
1	<i>Aethopyga ignicauda</i>	Fire-tailed Sunbird	Balchey	Nectarinidae	DS	1500 – 2700	NA
2	<i>Aethopyga nepalensis</i>	Green-tailed Sunbird	Kalobalchey	Nectarinidae	DS	1500 – 2000	LC
3	<i>Alcippe sp.</i>	White-throated Fulvetta		Sylviidae	IE	1500 – 2700	NA
4	<i>Arborophila torqueola</i>	Hill Partridge	Peura	Phasinidae	Call	1500 – 2700	LC
5	<i>Blythipicus pyrrhotis</i>	Bay Wood Pecker		Picidae	IE	1500 – 1950	NA
6	<i>Carpodacus rodochroa</i>	Rose Finch	Tuti	Fringillidae	DS	1500 – 4500	NA
7	<i>Cinclus cinclus</i>	White-throated Dipper		Cinclidae		1500 – 2300	LC
8	<i>Corvus macrorhyncus</i>	Large-billed Crow	Kaag	Corvidae	DS	1500 – 4500	LC
9	<i>Dendrocopos darjellensis</i>	Darjeeling Wood Pecker	Laachey	Picidae		1500 – 2300	NA
10	<i>Dicrurus macrocerus</i>	Black Drongo	Chibey	Dicaeidae		1500 – 1900	LC
11	<i>Enicurus maculatus</i>	Spotted Forktail		Muscicapidae		1500 – 1330	LC
12	<i>Eumyias thalassinus</i>	Verditer Flycatcher	Hariney	Muscicapidae	DS	1500 – 4500	LC
13	<i>Garrulax ocellatus</i>	Spotted Laughingthrush	Kolkoley	Turdidae	DS	1500 – 2700	LC
14	<i>Garrulax striatus</i>	Straited Laughingthrush	Kolkoley	Turdidae		1500 – 2300	NA
	<i>Hierococcyx sparveroides</i>	Large Hawk Cuckoo		Cuculidae		1500 – 2300	LC
16	<i>Ithaginis cruentus</i>	Blood Pheasant		Phasinidae	DS	1500 – 4500	LC
17	<i>Lanius tephronotus</i>	Grey-backed Shrike		Laniidae	DS		LC
18	<i>Leucosticte nemoricola</i>	Plain Mountain Finch		Fringillidae	DS		LC
19	<i>Lophura leucomelana</i>	Kalij Pheasant	Kaleej	Phasinidae		1850 – 2700	LC
20	<i>Lophophorus impejanus</i>	Himalayan Monal, Monal Pheasant		Phasianidae		2000 – 4500	LC
21	<i>Malacias capistratus</i>	Rufous Sibia		Leiostichidae			LC
22	<i>Mimla strigula</i>	Bar-throated Minla		Leiostichidae		1500 – 2700	LC
23	<i>Motacilla flava</i>	Yellow Wag Tail		Motacillidae			NA
24	<i>Myophonus caeruleus</i>	Blue Whishing Thrush	Kalchura	Turdidae		1100 – 2700	NA
25	<i>Parus monticolus</i>	Green-backed Tit	Fista	Paridae		2400 – 2700	LC
26	<i>Pericrocotus ethologus</i>	Long-tailed Minivet		Campephagidae			LC
27	<i>Pomatorhinus superciliaris</i>	Splender Bill Scimeter Babbler		Timaliidae		540 – 2464	NA
28	<i>Porphyrospiza caerulescens</i>	Finch	Tuti	Fringillidae			NT
29	<i>Scolopax rusticola</i>	Wood Cock		Scelopacidae			NA
30	<i>Streptopelia orientalis</i>	Oriental Turtle Dove	Dhukur	Columbidae			LC
31	<i>Tragopan satyra</i>	Satyr Tragopan	Mudal	Phasinidae		2700 – 4000	NT
32	<i>Turdus bouboul</i>	Grey-winged Black Bird		Turdidae		1800 – 2700	NA
33	<i>Upupa epops</i>	Common Hoopoe	Fafarey	Upupidae	DS		NA
34	<i>Urocissa flevirostris</i>	Yellow-billed Blue Magpie		Corvidae	DS	1500 – 2000	LC

Mammalian species							
1	<i>Ailurus fulgens</i>	Red Panda		Ailuridae		2200 – 4800	EN
2	<i>Capricornis thar</i>	Himalayan Serow		Bovidae		300 – 3000	NT
3	<i>Hystrix brachyura</i> Linnaeus	Himalayan Crestless Porcupine		Hystricidae		upto 1500	LC
4	<i>Lepus nigricollis ruficaudatus</i>	Rufous-tailed Hare	Jarayo	Leporidae		upto 2700	LC
5	<i>Martes flavigula</i>	Yellow-throated Marten		Mustelidae		upto 4500	LC
6	<i>Muntiacus muntjak</i>	Barking Deer	Mirga	Cervidae	DS		LC
7	<i>Nemorhaedus</i> sp.	Goral		Bovidae			
8	<i>Ochotona roylei</i>	Himalayan Mouse Hare, Royle's Pika		Ochotonidae		2400 – 5200	LC
9	<i>Paguma larvata</i>	Himalayan Palm Civet		Viverridae			LC
10	<i>Panthera pardus</i>	Common Leopard		Felidae		upto 5200	VUL
11	<i>Pardofelis marmorata</i>	Marbled Cat		Felidae		upto 2500	NT
12	<i>Prionailurus bengalensis</i>	Leopard Cat		Felidae		upto 4000	LC
13	<i>Sus scrofa</i>	Wild Boar		Suidae			LC
14	<i>Ursus thibetanus</i>	Himalayan Black Bear	Bhalu	Ursidae		upto 4300	VUL
15	<i>Vulpes bengalensis</i>	Bengal Fox, Indian Fox		Canidae		upto 1500	LC
16	<i>Pteromyini</i> sp.	Flying Squirrel		Sciuridae		upto 2700	
17	<i>Ratufa</i> sp.	Giant Squirrel		Sciuridae			
Butterflies							
1	<i>Aglais caschmirensis</i>	Indian Tortoiseshell		Nymphalidae	DS	600 – 5500	NA
2	<i>Euploea core</i> Cramer	Indian Common Crow		Nymphalidae	DS	ca. 3000	LC
3	<i>Vanessa cardui</i>	Painted Lady		Nymphalidae	DS	ca. 2700	NA

## CONCLUSION AND RECOMMENDATION

The population of species in terms of an individual plant density per hectare (Table 4) reveals that in the area, *Rhododendrons* are the highly dominant taxa in the area, followed by Fir (*Taxus wallichiana*, *Abies densa*, *Tsuga Dumosa*) and Oak (*Lithocarpus pachyphyllus*), species of *Acer*, *Magnolia*, *Eurya*, *Symplocos* and so on. On comparison of the population of tree species, there estimated quite increase in the population especially of *Rhododendrons*, which may be due to plantation programme in the mean time, as well as may be due to growth of the available seedlings and saplings in the area. On contrary to the previous report (RBSIII, 2018) *Taxus wallichiana* has been recorded with good number of population (Density (ind/ha) = 69.697), which was not listed in the previous report, which may be due to identification issue.

The diversity value index ( $H'$ ) has been estimated slightly higher ( $H' = 2.473$ ) during 2019 as compared to previous report of 2017 ( $H' = 2.368$ ), the reason for which may be due to post monsoon visits in which more number of species were inventorized, especially ground flora.



**Table 4: Comparison of the population of trees in terms of individual plant density per hectare**

Species	2017	2019
	Density (ind/ha)	Density (ind/ha)
<i>Abies densa</i>	51.52	21.212
<i>Acer campbellii</i>	6.06	6.061
<i>Acer pectinatum</i>	39.39	45.45
<i>Cryptomeria japonica</i>	-	9.091
<i>Eurya acuminata</i>	-	15.152
<i>Lithocarpus pachyphylla</i>	124.24	124.24
<i>Magnolia campbelli</i>	33.33	39.39
<i>Magnolia doltsopa</i>	9.09	12.12
<i>Nyssa sessiliflora</i>	-	3.030
<i>Rapanea capitellata</i>	-	6.061
<i>Rhododendren arboreum</i>	315.15	315.15
<i>Rhododendren arboreum</i> (pink)	45.45	69.697



<i>Rhododendron barbatum</i>	100.0	103.03
<i>Rhododendron falconeri</i>	351.52	118.18
<i>Rhododendron grande</i>	-	75.75
<i>Rhododendron griffithianum</i>	-	3.030
<i>Rhododendron hodgsonii</i>	66.67	78.788
<i>Rhus insignis</i>	-	6.061
<i>Symplocos lucida</i>	33.33	33.030
<i>Taxus wallichiana</i>	-	69.697
<i>Tsuga dumosa</i>	39.39	39.394
<i>Yushania maling</i>	-	55.263

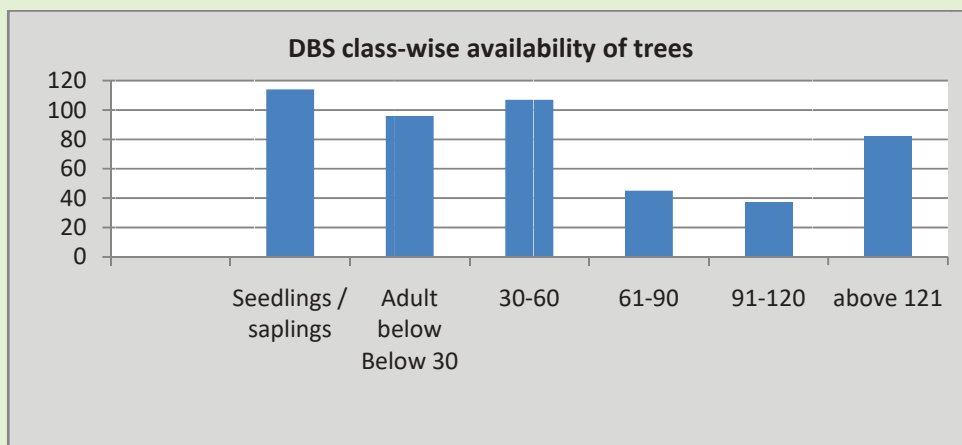
In case of the population of shrubs, shrublets and herbs, no much change were observed, despite the addition of some more species in the present survey. The shrubs and shrublets recorded from the sample plots are *Viburnum erubescens*, *Viburnum grandiflorum*, *Rubus* sp., *Eurya acuminata*, *Symplocos theifolia*, *Daphne papyraceae*, *Rhododendron barbatum* and *Gaultheria nummularioides* *Ardisia macrocarpa*. Diversity of the ground covering herb species in the area was recorded high, but in terms of density, percent cover and percent frequency, the values were comparatively less in the area, which may be because of the high canopy cover inside the forest. Some of the globally threatened species recorded in the high altitude, in and around Deonigali Dhap, Thulo Dhap, Dhajey Dara are *Aconitum palmatum*, *Aconitum* sp., *Polygonatum* sp. *Paris polyphyllum*, *Panax bipinnatifidus* etc. with very less number of population. The porous border in between Nepal and India at Chewabhanjyang appear to be the threat for biodiversity of the sanctuary especially for high market value medicinal plants, other non timber and timber produce of the sanctuary, which addresses immediate management attention.



**Picture of Barsey Rhododendron Sanctuary showing international porous border at Chewabhanjyang**

### **RE-GENERATION STATUS / FOREST HEALTH STATUS**

Forest re-generation status or forest health status was analyzed on the basis of tree diameter class, wherein, the high availability of the seedlings, saplings and adult trees in the forest shows that the status of the forest is stable.



**Figure 2: DBH class wise availability (in cm) of the available trees at Barsey Rhododendron Sanctuary**

The availability of saplings and seedlings found highest in case of the species of rhododendrons especially *R.arboreum*, *R.falconeri*, *R.hodgsonii*, and so on, followed by *Taxus wallichiana*, *Abies densa*, *Tsuga dumosa*, species of *Acer*, species of *Viburnum* and recorded lowest in case of *Lithocarpus pachyphyllus* (Oak).

**Photo plate 2: Regeneration of species at Barsey Rhododendron Sanctuary**











**Sikkim Biodiversity Conservation and Forest Management Project (SBFP)**

Forest and Environment Department

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