

## 3<sup>rd</sup> HIMALAYAN RESEARCH SEMINAR

Monday, 10<sup>th</sup> September 2018

### PROGRAMME

Seminar Chairperson: Prof. M.K. Pandit

#### INAUGURAL SESSION

0930 – 0935	Welcome	<b>Dr. S. Sathyakumar</b> , Scientist-G, WII
0935 – 0945	Opening Remarks	<b>Dr. G.S. Rawat</b> , Dean, WII
0945 – 1000	Inaugural address	<b>Dr. Anil Joshi</b> , Founder, HESCO

#### TECHNICAL SESSION – I

##### ECOLOGICAL PATTERNS

**Chair : Dr. S. Sathyakumar, Scientist-G**

**Co-Chair(s) : 1. Dr. K. Ramesh, Scientist-E**

**2. Dr. Salvador Lyngdoh, Scientist-D**

1000-1015	Influence of environmental parameters on soil microbial community function across alpine habitats in the Indian Himalayan Region <b>Pamela Bhattacharya</b> , Senior Research Fellow
1015-1030	Community analysis of soil-inhabiting nematodes in Gangotri National Park, Uttarakhand <b>Priyanka Kashyap</b> , Junior Research Fellow

1030-1045	Small organisms, Big revelations! Macroinvertebrate assemblage defining 'Climate Sensitive Zones' in Himalayan River Basins <b>Aashna Sharma</b> , Senior Research Fellow
1045-1100	Role of local and landscape factors in shaping the river bird community in the Western Himalaya: A case-study <b>Ankita Sinha</b> , Junior Research Fellow
1100-1115	Elevation effects on small carnivores in Great Himalayan National Park, Himachal Pradesh <b>Meghna Bandopadhyay</b> , Junior Research Fellow
1115-1130	<b>Discussion &amp; Remarks by Chair and Co-Chairs</b>
1130-1145	<b>Tea</b>

## TECHNICAL SESSION – II

### AQUATIC ECOLOGY

**Chair : Dr. S. A. Hussain, Scientist-G**

**Co-Chair(s) : 1. Dr. J. A. Johnson, Scientist-E**

**2. Dr. Abhijit Das, Scientist-D**

1145-1200	Water Quality Characterization with the help of Aquatic Macroinvertebrates  <b>- Anjani Rawat</b> , Junior Research Fellow
1200-1215	Determinants of Odonata species distributions in the Indian Himalayan Region: Comparison among Past, Present and Future Scenarios  <b>Shuvendu Das</b> , Junior Research Fellow
1215-1230	A Peep into the Past: Sclerochronological expression of age and growth performances among fish populations in Himalayan streams <b>Dr. Vineet Kumar Dubey</b> , Project Associate
1230-1245	Factors governing diversity and distribution of amphibians in Western Himalaya and Eastern Himalaya  <b>Naitik Patel</b> , Project Fellow
1245-1300	<b>Discussion &amp; Remarks by Chair and Co-Chairs</b>
1300-1345	<b>Lunch</b>

1345 - 1430

**POSTER SESSION**

12 Posters

**TECHNICAL SESSION – III**

**HUMAN DIMENSION AND INTERFACE**

**Chair : Shri Ajay Srivastav, Scientist-G**

**Co-Chair(s) : 1. Dr. Gopi, G.V., Scientist-E**

**2. Dr. Samrat Mondal, Scientist-D**

1430-1445

Indicator based assessment of socio-economic vulnerability to climate change in the Indian Himalayan Region

***Dr. Soumya Dasgupta***, Project Associate

1445-1500

The Status of Leopard, its Prey and Perception of Local Communities in Dooars, North Bengal

***Ashish Kumar Jangid***, Project Fellow

1500-1515

Synanthropic cousins: Rhesus macaques in Chandrabani

**Sayli Sawant**, Project Fellow

1515-1530

Population status of Common leopard, Prey and Perception of local communities towards Human-Leopard Conflicts in Pauri Garhwal, Uttarakhand

**Gaurav Sonkar**, Junior Research Fellow

1530-1545

**Discussion & Remarks by Chair and Co-Chairs**

1545-1600

**Tea**

**TECHNICAL SESSION – IV**

**ECOLOGY AND MODELING**

**Chair: Dr. V.P. Uniyal, Scientist-G**

**Co-Chair(s) : 1.Dr. Gautam Talukdar, Scientist-E**

**2. Dr. Sutirtha Dutta, Scientist-D**

1600-1615

Risky homes with easy food: Denning of the generalist and widely distributed carnivore red fox

***Mr. Hussain Reshamwala***, Senior Research Fellow

1615-1630 Abiotic and biotic determinants of species distribution: a case study of snow leopards of Upper Bhagirathi basin, Western Himalaya  
***Ms. Ranjana Pal***, Senior Research Fellow

1630-1645 Modelling present distribution and predicting future spread of two invasive alien plants in Kailash Sacred Landscape- India  
***Alka Chaudhary***, Junior Research Fellow

1645-1700 **Discussion & Remarks by Chair and Co-Chairs**

**TECHNICAL SESSION – V**  
**PLANT ECOLOGY AND ETHNOBOTANY**

**Chair : Dr. B. S. Adhikari, Scientist-F**

**Co-Chair(s) : 1. Dr. Malvika Onial, Scientist-E**  
**2. Dr. Amit Kumar, Scientist-C**

1700-1715 Population status of high value medicinal and aromatic plants in Chenab valley, Jammu & Kashmir  
***Dr. Suresh kumar Rana***, Senior Research Fellow

1715-1730 Snowmelt timing regulates herbaceous community composition and phenology of alpine plants  
***Mr. Rahul Kumar***, Junior Research Fellow

1730-1745 Status of traditional ecological knowledge among two indigenous ethnic communities of Pithoragarh, Uttarakhand  
***Dr. Naveen Chandra Joshi***, Project Associate

1745-1800 **Discussion & Remarks by Chair and Co-Chairs**

**1800-1815 Concluding Remarks by the Seminar Chairperson**

1815-1820 Vote of Thanks  
***Dr. K. Vishnupriya***, Scientist-C

### 3<sup>rd</sup> Himalayan Research Seminar: List of Posters

S. No.	Title	Presenter
1.	Physico-chemical characteristics of top and subsoil across alpine habitats in Gangotri National Park	Gunjan Gulati & Anjali Uniyal
2.	Anthropogenic influences on site utilization by carnivores in the Great Himalayan National Park, Himachal Pradesh	Shagun Thakur
3.	Analyzing community structure and species distribution of sympatric carnivores in Bhagirathi basin through genetic approach	Anshu Panwar & Malvika Pandey
4.	Adaptive Management of Pollinators through Community Participation in the Spiti Valley, Himachal Pradesh, Indian Trans Himalayan Region	Mona Chauhan
5.	Spatial patterns of Human-Elephant Conflicts in Dooars landscape, North Bengal".	Suraj Kumar Dash
6.	Preliminary investigations on HWC in Chamba region, Himachal Pradesh	Nitin Bhushan
7.	Technological Interventions to Enhance the Livelihood of Mountain Communities	Charuhas Dali
8.	Response of subalpine and alpine plant communities to experimental warming.	Chirag Girdhar
9.	Status of agriculture and crop landrace diversity in Pithoragarh district, Uttarakhand	Rishabh Srikar
10.	Valuation of Ecosystem Services (ESS) Flowing from a Community Managed Forest in Dhauladhar Range, Himachal Pradesh	Dr. Anjali Uniyal
11.	Long-term environmental and ecological monitoring in Sikkim Himalaya	Dr. Rishi Kumar
12.	Linking Communities with Conservation in Maenam Wildlife Sanctuary, Sikkim: Opportunities and Challenges	Paridhi Jain

## Influence of environmental parameters on soil microbial community function across alpine habitats in Indian Himalayan region

- Pamela Bhattacharya

Alpine ecosystems are sensitive to climate change and offer an opportunity to study effects of changing climate on plant species composition, soil properties and microbial communities. In this study we aim to investigate the influence of varied climate regime along with environmental parameters on soil microbial community function in western and eastern alpine habitats of the Indian Himalayan Region (IHR).

This study was conducted along elevation gradient (3000-4000 m) of Gangotri National Park (GNP), Uttarakhand and Khangchendzonga National Park (KNP), Sikkim covering major alpine and sub-alpine habitats within IHR.

We used a combination of soil sampling, experimental warming, soil characterization and biochemical enzyme assays to determine environmental influence on microbial community function. Soil samples from alpine and subalpine habitats covering birch-rhododendron forests, subalpine scrubs, alpine scrubs and alpine herbaceous sedge meadows were collected during different seasons. Soil physico-chemical characterization and biochemical estimation of Beta glucosidase and Phenol oxidase activities were determined for microbial function in soil organic carbon degradation. Open Top Chambers (OTCs) were set up (n=10) in alpine and subalpine habitats in GNP for monitoring changes in microbial community composition and function under experimental warming.

Chemical analysis of soils from alpine and subalpine habitats showed significant differences for pH, moisture, nutrient contents (C and N) and C:N ratio between western and eastern habitats (Mann-Whitney U-test,  $P < 0.05$ ). Soil moisture correlated positively with nutrient content and C:N ratio in both the parks, whereas Beta glucosidase activity showed negative correlation with soil moisture in KNP. Twenty months of experimental warming showed differential response in individual OTCs in alpine habitat.

The results indicate that soil moisture, pH and nutrient contents (C and N) may be some of the most important environmental factors influencing soil microbial communities in IHR. Analysis of soil bacterial and fungal communities facilitated by next generation sequencing would be critical to understand influence of environmental parameters on microbial community diversity, composition and function.

**Key Words:** Climate change, environmental variables, bacteria and fungi, open top chambers.

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. G.S Rawat and Dr. G. Talukdar
<b>Researcher(s)</b>	: Pamela Bhattacharya (Senior Project Fellow)
<b>Funding Agency</b>	: DST-NMSHE
<b>Project Duration</b>	: 2014-2015 to 2018-2019

## Community analysis of soil inhabiting nematodes in Gangotri National Park, Uttarakhand, India

- *Priyanka kashyap*

Soil nematode communities provide the understanding of some of the vital soil ecological processes and function and therefore, they can be used as the measure of soil health of any region. As no such data is documented for alpine areas in Uttarakhand, our aim is to provide the baseline data for community structure of soil nematodes in one of the alpine areas of the State. We selected Gangotri National Park (GNP) which forms the upper catchment of the Bhagirathi Basin as our study area. We used stratified random sampling to collect soil samples along an elevation gradient (3000-4000m) in Gangotri Valley. Soil samples were collected at 10-20 cm depth using soil auger of diameter 3cm. Six to ten composite soil samples were collected representing an elevation category of every 100m elevation. Nematodes were extracted using decantation and sieving method. Nematodes were identified up to the genus level by BX53 DIC/BF Olympus research microscope with an attached DP27 digital camera. Nematode genera were allotted to trophic groups and colonizer-persister groups and ecological indices were calculated. A total of 17 randomly selected composite samples yielded 30 genera belonging to 14 families of six orders. Order Dorylaimida (37%) were the highest in number, followed by Araeolaimida (28%) and least number was of Mononchida (5%). Plectus was the most dominant genera in terms of abundance (23.4%) followed by Cylindrolaimus (14.1%). These 30 genera were assigned to different trophic groups according to their feeding habit with bacteriovores (42.4%) having highest number followed by omnivores, plant parasites, predators and fungivores. Nematode channel ratio (0.72) represents the bacterial decomposition pathway in the region. High nematode diversity ( $H'=3.2$ ) and high maturity indices (2.78) showed fewer disturbances in the Gangotri Valley. This study depicted that the soil of GNP is healthy in terms of soil ecological processes and less impacted due to disturbances. The baseline information regarding relative abundance, maturity indices and ratio of bacteriovors and fungivores can be used as soil health indicators for long-term climate change impact assessment studies. Key Words: Ecological indices, Abundance, Bacteriovors, Trophic group.

<b>Project Title</b>	: Diversity of nematode and its role as bio indicator of climate change in the Indian Himalaya Region
<b>Principal Investigator(s)</b>	: Dr. V.P. Uniyal & Dr. Anjum Nasreen Rizvi
<b>Researcher(s)</b>	: Priyanka Kashyap (Junior Research Fellow)
<b>Funding Agency</b>	: National Mission for Himalayan Studies (NMHS)
<b>Project Duration</b>	: 2016-2019

## Small organisms, big revelations! Macroinvertebrate assemblage defining 'Climate Sensitive Zones' in Himalayan river basins

- *Aashna Sharma*

Freshwater ecosystems of high altitudes are highly responsive to climate change. The Himalayan high-altitude stream biota, thus, are specifically susceptible. Macroinvertebrates are brilliant study organisms to understand the effects of climate change due to low dispersal abilities and high environmental specificity. This study aimed at delineating zones in the Himalayan streams which are sensitive to climate based on community thresholds.

Tirthan River of the Beas River Basin, Great Himalayan National Park in the north-west Himalaya (total streams  $n=25$ , stream stretch =168km) and various streams of Bhagirathi River Basin (total streams  $n=16$ , stream stretch =104km) including Gangotri National Park in the western Himalaya were sampled.

Macroinvertebrates were sampled at every 200m for lower and 500m for higher order streams by using kick and drag netting. A total of 37 physico-chemical and habitat variables were recorded at each of the 178 points, ranging from 989 to 4569msl. Identifications of macroinvertebrates were done upto family level using stereoscopic microscope. Bioclimatic variables viz. Bio1 and Bio12 data were extracted to points from WorldClim data set. Classification and Regression Trees (CART) and Generalised Additive Models (GAM) were fit to environmental data to determine the best predictor variable. Threshold Indicator Taxa analysis (TITAN) was used with 500 bootstrap cycles to determine Climate Sensitive Zones (CSZ) for both the basins. Analyses were performed using R ver.3.4.1.

Macroinvertebrates sampled from Beas ( $n=2204$ ) and Bhagirathi Basins ( $n=1541$ ) revealed a total of 59 and 39 families respectively. PCA followed by CART model revealed altitude to be the final predictor variable ( $p<0.01$ ). TITAN revealed a total of 4 ( $z=-3$ ,  $z+=1$ ) indicator families for Bhagirathi and 11 ( $z=-9$ ,  $z+=2$ ) for Beas. Community change score values derived from TITAN delineated CSZ from 1593 to 2383 masl and 2318 to 4328 masl for Beas and Bhagirathi Basins respectively.

CSZs identifications through this study would help in solving the difficulties monitoring climate in dynamic systems. Repetitive monitoring of these identified zones would help in tracking climate change.

**Key Words:** Climate change, community thresholds

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. K. Sivakumar, Dr. J.A. Johnson
<b>Researcher(s)</b>	: Aashna Sharma (Senior Project Fellow) and Dr. Vineet K. Dubey (Project Associate)
<b>Funding Agency</b>	: DST-NMSHE
<b>Project Duration</b>	: 2014-2019



## Role of local and landscape factors in shaping the river bird community in the Western Himalaya: A case-study

- *Ankita Sinha*

Himalayan river systems are undergoing major modifications influenced by changes in land use, climate and hydropower development. However, these effects on river dependent species such as birds are hitherto poorly quantified and understood. River birds form significant components of wildlife along linear waters in the Himalaya which harbour the highest richness of specialist river birds in the world. This study aims to understand the relative influence of landscape patterns and microhabitat variables on bird communities and in what contexts each of these spatial scales are more important.

The study was conducted in headstreams of the Upper Ganges, the Bhagirathi and Amrit Ganga basins in the state of Uttarakhand in the western Indian Himalaya.

Riverine birds were recorded along 52 replicate trails (n=42 in the Bhagirathi basin, and n= 10 in the Amrit Ganga basin) which were established systematically across an elevational gradient of 330-3200m asl. At these sampling units, micro-habitat variables including river channel features, flow type, substratum type, bank vegetation structure, adjacent land-use and developmental activities on both banks were recorded. Remotely sensed data for elevation, land-use, human footprint, nightlight and climatic variables were used for coarse-scale analysis. We analysed community patterns and individual species' responses to both scales with Canonical correspondence analysis and generalized linear models.

Local factors explained one and a half times more variance than landscape factors for overall species diversity. Fine scale habitat factors explained 32 % variability of the data against landscape scale factors which explained only 24 %. River bird distribution reflected channel character, bank morphology and aspects of river flow, but also human activities including land use. Obligate riverine birds showed a common trend for both the scales, avoiding modified riverine habitat.

We conclude that the distribution of the overall riverine bird community in the Western Himalaya is influenced by both landscape factors and micro-habitat parameters. Although micro-habitat features best explain the distribution of individual species, effects are most prominent for obligate riverine birds.

<b>Project Title</b>	: National Mission on Himalayan Studies (Rivers birds in Upper Ganges)
<b>Principal Investigator(s)</b>	: Dr. K. Ramesh (PI); Dr. B.S.Adhikari (Co-PI)
<b>Researcher(s)</b>	: Ankita Sinha (Junior Research Fellow)
<b>Funding Agency</b>	: MoEFCC
<b>Project Duration</b>	: June 2016 - June 2019

## Elevation effects on small carnivores in Great Himalayan National Park, Western Himalaya

- *Meghna Bandyopadhyay*

Small carnivores have diverse functional roles and being elusive they are the least studied species. The aim of the study is to assess the response of small carnivores such as red fox, leopard cat and yellow throated marten to elevation in terms of relative abundance.

The study was carried out in the Great Himalayan National Park, Kullu District, Himachal Pradesh.

Systematic camera trapping across five different elevation blocks from 1500m to 4000m in two different seasons; summer and winter was executed. The relative abundances for the three small carnivores were estimated based on 1) the proportion of detection sites, and 2) the detection rate per 100 trap night. Mann-Whitney U test was performed at  $\alpha=0.05$  to detect statistical significance. Count data was analysed to understand the effect of elevation with other covariates like distance to river and village using generalized linear mixed models (GLMMs). Best model was chosen based on AIC values. Power analysis was used to determine the sample size required to detect a significant elevation effect.

All the three species showed elevation effect across the seasons, although there were local variations in the relative abundance. In both the seasons the proportion of detection sites was more than 50% at higher elevation for all these small carnivores, but yellow throated marten had relatively maximum detection sites in lower elevation during winter. The detection rate for red fox was found to be always more at higher elevation ( $p\text{-value}=0.012$ ) whereas for leopard cat the peak showed at middle elevation ( $p\text{-value}=0.028$ ) and yellow throated marten always showed higher detection rates at lower elevation ( $p\text{-value}=0.030$ ). Poisson and negative binomial models being the better models depict non-linear distribution of small carnivores with maximum detections occurring at somewhere middle elevation. Due to low detections only few of the effect sizes were significant. Hence power analysis resulted in an increase of number of locations from 60 to 80 in order to detect a significant elevation effect on small carnivores.

**Key words:** relative abundance, power analysis, red fox, leopard cat, yellow-throated marten

<b>Project Title</b>	: Small carnivore interactions and its anthropogenic correlates along the elevation gradient in Western lesser Himalaya
<b>Principal Investigator(s)</b>	: Dr. K. Ramesh
<b>Researcher(s)</b>	: Meghna Bandyopadhyay (Junior Research Fellow)
<b>Funding Agency</b>	: National Mission for Himalayan Studies (NMHS)
<b>Project Duration</b>	: 3yrs

## Water Quality Characterization with the help of Aquatic Macroinvertebrates

- Anjani Rawat

Himalayan rivers are the symbol and the source of pristine water and aquatic macro-invertebrates play major role in shaping its ecology and self-purification capacity. The vast richness, diversity and adaptability of aquatic macro-invertebrates with changing hydrological regimes make them one of the successful aquatic dwellers. However, their assemblage in various proportions reveals a lot about the changing ecological dynamics of river and its health profile.

Hence considering the fact, the study was carried out in 10 spatially located sampling stations with each sampling station consisting of 10 sub-sampling points (n=100) in Mandakini River, exposed to various degrees of environmental stresses, to explore the macro-invertebrate diversity and factors effecting its distribution in pre and post monsoon season. On the basis of degree of anthropogenic stresses, locations were divided into least (Sonprayag), medium (Ukhimath) and high disturbance (Rudraprayag) sites.

A total of 3257 individuals belonging to 7 orders and 21 families were found in both the sampling seasons, among which order Diptera and Trichoptera was dominant orders. Shannon diversity index revealed that the diversity of macro-invertebrates decreased with increase in anthropogenic disturbances. One way ANOVA showed a significant difference in diversity between pre and post monsoon season ( $p < 0.05$ ).

Results from %EPT (Ephemeroptera, Plecoptera and Trichoptera) showed that the sensitive insects' orders were vulnerable to the anthropogenic stresses and thus can be used for water quality assessment in Himalayan Rivers. Canonical Correspondence Ordination (CCA) for pre and post monsoon season reveals that the distribution of macro-invertebrates was strongly influenced by dissolved oxygen, velocity and temperature. Dissolved oxygen played a decisive role in shaping macro-invertebrate diversity and its assemblage.

It can be concluded from the above study that macro-invertebrates acts as potential indicator for water quality monitoring in Himalayan Rivers and hence macro-invertebrates needs a long term monitoring for robust information of a river.

**Key words:** Himalayas, Mandakini River, Aquatic Macroinvertebrates, %EPT index, Dissolved Oxygen.

<b>Project Title</b>	: Awareness and capacity building for monitoring the health of Environment
<b>Principal Investigator(s)</b>	: Dr. VP Uniyal, Co-PI - Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Anjani Rawat (Himalayan Research Fellow)
<b>Funding Agency</b>	: National Mission on Himalayan Studies (NMHS)
<b>Project Duration</b>	: 2016-2019

## Determinants of Odonata species distributions in Indian Himalayan region: Comparison among past, present and future scenarios

- Shuvendu Das

The study aimed to ascertain the influence of altitude, seasonality, vegetation types, environmental parameters, aquatic composition and anthropogenic factors that likely affect Odonata assemblages and distribution.

Indian Himalayan Region (IHR~60,000 km<sup>2</sup>) and Bhagirathi River Basin (BRB~7,000 km<sup>2</sup>), Uttarakhand.

Stratified random sampling was carried out in at least 10 plots at each 250m elevation interval within a range of 500m-4000m. Various thematic layers were generated using ArcGIS 10.2 for assessing species distribution through Analytical Hierarchy Process(AHP). MaxEnt software was used to predict distribution of selected Odonata species Bhagirathi river basin as well as IHR landscape. A total of 49 variables (topographic, climatic, and anthropogenic) were used to run the model to produce probable distribution maps followed by intensive ground truthing verification.

Preliminary assessment led to listing of 85 species of Odonates belonging to 45 genera and 12 families. Based on different Bio-climatic layers using MaxEnt predictive models, suggested during mid-holocene period *Aeshna petalura* was likely distributed over 13,248 sqkm, present day its predicted distribution covered 1,69,988 sqkm and in 2050 it would be distributed in 78,000 sqkm in IHR. Our present distribution model testing suggest that the species distribution is underestimated. There has been drastic shift in species response to temperature seasonality after Last Interglacial. Climatic niche was restricted; drastic reduction in range after Last interglacial period.

In future, negative impact of habitat degradation and impacts of changes in microclimatic factors on distribution and diversity of Odonates will be investigated. The applicability of Odonates as surrogate to monitor climatic or human-caused changes in habitats will be studied.

**Key words:** Bhagirathi River Basin, Odonates, Systematic sampling, Bio-climatic.

<b>Project Title</b>	: Diversity and distribution of odonata assemblages along altitudinal gradient in the selected river basins of Bhagirathi and Teesta in relation to environmental parameters
<b>Principal Investigator(s)</b>	: Dr. V.P. Uniyal and Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Shuvendu Das (Himalayan Junior Research Fellow)
<b>Funding Agency</b>	: National Mission on Himalayan Studies (NMHS)
<b>Project Duration</b>	: 2016-2019

## A peep into the past: sclerochronological expressions of age and growth performances among fish populations in Himalayan streams

- Dr. Vineet Kumar Dubey

Age and growth are important variables representing individual fitness while pertinent body growth can reveal adaptations to environmental change and inter/intra-specific competition. Due to dearth of studies conducted on linking ageing to climate and competition, this study was conducted to monitor the life history traits specifically the age-growth profiles of native snow trout (*Schizothorax richardsonii*) and non-native brown trout (*Salmo trutta fario*) populations in the tributaries of Bhagirathi and Beas river basins.

This study was conducted in the Rivers Asiganga and Tirthan, which are major tributaries of Bhagirathi and Beas respectively. Tirthan, falling in the Great Himalayan National Park is pristine and undammed, which serves as a perfect comparison for Asiganga affected by human interventions.

Fish samples were collected from April 2017 to July 2018, using cast, drag and kick nets from confluence to origin of both the rivers. Age determinations were carried out using standard sclerochronological analyses. Possible differences in growth rates among populations were back-calculated. Growth parameters were estimated by fitting the von Bertalanffy growth curve. The mean length at first maturity (L50) was estimated using samples collected during the reproductive periods.

The estimated mean length in age-1 class of snow trout from Asiganga was  $17.38 \pm 1.2$  cm however, in Tirthan it was  $20.2 \pm 1.2$ . A significant difference in length-at-age in all age classes (youngest, intermediate and oldest) of brown trout and snow trout populations of Asiganga and Tirthan river populations were recorded ( $p < 0.05$ ). Non-native brown trout (Condition factor,  $K = 1.09 \pm 0.14$ ) is able to maintain its body condition, while native snow trout fails to do so ( $K = 0.92 \pm 0.26$ ). The reproductive strategies reveal a strong response of snow trout to the brown trout with a higher gonado-somatic index (GSI) at all maturity stages of male ( $F = 27.87$ ,  $p < 0.005$ ) and female ( $F = 30.23$ ,  $p < 0.005$ ).

The present study would help in providing considerable insights into the population and community consequences, especially for species that are more prone to environmental alterations.

**Key words:** Life history, back-calculation, growth

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. K. Sivakumar, Dr. J.A. Johnson
<b>Researcher(s)</b>	: Dr. Vineet Kumar Dubey (Project Associate) and Aashna Sharma (Senior Project Fellow)
<b>Funding Agency</b>	: DST-NMSHE
<b>Project Duration</b>	: 2014-2019

## Factors governing diversity and distribution of amphibians in Western Himalaya and Eastern Himalaya

- Naitik Patel

The potential factors structuring amphibian species richness in Eastern and Western Himalaya remains poorly understood. Here we are trying to identify species richness and diversity of stream amphibians in Bhagirathi basin, Western Himalaya and Tista basin, Eastern Himalaya and to identify major drivers for such pattern.

We conducted field sampling in Bhagirathi river basin (BRB), Uttarakhand and Tista river basin (TRB), Sikkim.

We conducted nocturnal visual encounter survey (time constrained) along with opportunistic observation (n=188) across elevation band. For each encounter (n= 672), we recorded body and surface temperature °C and relative humidity (%) using a Hygro Thermometer. We collected fourteen environmental parameters across sites (n=188). We used Pearson correlation between body and surface temperature. We used principal component analysis to delineate morphology of closely related species. The distribution pattern of stream frogs was analyzed using non-metric multidimensional scaling (NMDS) ordination with respect to different microclimatic features (n=12).

Thirty one species of amphibians were recorded during the survey. Estimated species richness was  $12 \pm 0.24$  (Chao 2 estimates) in BRB and  $23 \pm 0.24$  (Chao 2 estimates) in TRB. Sorensen similarity index score between BRB and TRB was 0.022. Our study shows “mid domain” effect in species richness in both the basin. Stress value for NMDS is 0.06 that explains microhabitat variables for stream frogs across two sites. The body temperature of amphibians is positively correlated with surface temperature ( $r = 0.92$ ). Relative humidity of amphibians is higher in TRB compared to BRB.

TRB is having higher species richness compared to BRB as revealed by species accumulation curve. Constant moisture gradient along the elevation allow more amphibian species to occupy different niches in Eastern Himalaya compare to Western Himalaya. However, the microclimatic requirement for amphibians is species specific. Thus, to safeguard this diversity across elevation we need to conserve species specific microhabitat requirements.

**Key words:** Ectothermy, Diversity, Abiotic factors, Herpetofauna.

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. Abhijit Das
<b>Researcher(s)</b>	: Naitik Patel (Project Fellow)
<b>Funding Agency</b>	: DST-NMSHE
<b>Project Duration</b>	: 2014-2019

## Indicator based assessment of socio-economic vulnerability to climate change in the Indian Himalayan Region

- Dr. Soumya Dasgupta

To assess the climate change vulnerability of the people residing in the Indian Himalayan Region taking Bhagirathi basin of Western Himalaya as a model.

The study was carried out in Uttarkashi and Tehri Garhwal district of Uttarakhand

Information from Census India 2011 was collated to identify the villages of Uttarkashi and Tehri Garhwal District for sampling. A mixed approach was taken and both secondary and primary survey data was used to cluster the villages at different levels for selection of villages for detailed household level survey. Two step algorithm forms 11 different clusters on the basis of altitude, geographical area, exposure to climate change shocks and remoteness index, were formed. From these 11 clusters 30 villages were selected wherein, 646 households were surveyed using predesigned semi-structured questionnaire to collect information on different components of vulnerability and resilience. Indicators were identified and classified within human, natural, financial, physical and social capital using an inductive approach. Both household and village level vulnerability of social and economic aspects were calculated adding up the normalized value of each indicators from the five different capitals.

Both household and village level vulnerability is higher in the villages of Tehri Garhwal district compared to Uttarkashi District. Clusters analysis was done with the vulnerability scores generated, to classify the households and villages according to their vulnerability and group them in high, medium and low vulnerable categories.

Identifying the vulnerable group or clusters have manifold implication in the policy and intervention level to deal with climate change shocks. Vulnerability analysis allows important distinctions to be made between the vulnerable and resilient groups of the population and prepare safety nets/ interventions. There is a need of strategies to prepare the vulnerable community to be resilient to the mixed effects of climate change on cropping pattern, availability of multiple ecosystem services, biodiversity and system health.

**Key words:** Vulnerability, indicators, capitals, Indian western Himalaya, Bhagirathi Basin

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. Ruchi Badola, Dr. Asha Rajvanshi
<b>Researcher(s)</b>	: Soumya Dasgupta (Project Associate)
<b>Funding Agency</b>	: DST-NMSHE
<b>Project Duration</b>	: 2014-2019

## The status of leopard, its prey, and perception of local communities in Dooars, North Bengal

- Ashish Kumar Jangid

Leopard (*Panthera pardus*) is considered a problem species in most landscapes where they share space with humans. In the eastern Himalayan foothills (Dooars region of West Bengal), there have been reports of more than 500 attacks on humans by leopard between 1990-2016. The aim of the present study was to assess the population status of leopard, its prey and also understand the perception of local communities towards leopards.

The study was conducted in Mahananda Wildlife Sanctuary and Gorumara National Park, located in the western and central parts of North Bengal.

Leopard density was estimated in an area of 158 km<sup>2</sup> of Mahananda WLS by deploying 42 camera traps using SECR framework in a systematic 5 km<sup>2</sup> grid design. An effort of 630 trap night was invested between May-June 2018. We also conducted surveys (N=225) using semi-structured questionnaires in the vicinity of Mahananda and Gorumara protected areas to understand the perception of people. Major drivers of perception were identified using multinomial logistic regression. Capture rate (#/100 trap nights) of major wild prey species were assessed to compute an index of relative abundance. Free ranging dog abundance and density were estimated within an area of 91km<sup>2</sup> (excluding protected areas) on 10 selected trails using conventional Mark-Resight approach.

Leopard density was estimated as 4.31 (SE 2.79) per 100 km<sup>2</sup>. We recorded maximum photo capture rate for cattle (151.43), followed by barking deer (6.67), wild pig (3.17), sambar (0.32) and chital (0.32). Dog abundance and density was estimated to be 699 (SE 21.19) and 7.68 (SE 0.23) per km<sup>2</sup> respectively within the peripheral areas of Mahananda. Sixty-seven percent of the respondents were positive towards conservation of leopards. Number of generations lived in the area, type of livestock owned, perceived ecological role of leopard and pragmatic suggestions to reduce conflicts were significant predictors of attitude towards leopard. Relationship between the significant predictors and attitude will be discussed.

**Key words:** Human-dominated landscape, carnivores, assessment, free ranging domestic dogs.

<b>Project Title</b>	: Human- wildlife conflict resolution mechanism in the Indian Himalayan Region: Risk assessment, Prediction, and Management through Research and Community engagement (NMHS-HWC Project)
<b>Principal Investigator(s)</b>	: Dr. G.S. Rawat and Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Ashish Kumar Jangid (Senior Project Fellow)
<b>Funding Agency</b>	: NMHS and Ministry of Environment, Forest and Climate Change, Government of India
<b>Project Duration</b>	: 2016-2019



## Synanthropic cousins: Rhesus macaques in Chandrabani

- Sayli Sawant

Human-Rhesus macaque (*Macaca mulatta*) conflict is a major management issue across its distributional range and in some areas it even influences local politics. Availability of food, both cultivated and in the form of garbage, in human dominated landscapes has provided easy resources to rhesus macaques. In order to control this predicament, it is pertinent to understand their ranging and foraging patterns; the primary aim of this study.

This study was conducted in a 16km<sup>2</sup> area in and around Wildlife Institute of India, Chandrabani, Dehradun.

Data on behaviour, activity, and ranging patterns of five troops of macaques using scan and focal animal sampling (700 hours of observation) were recorded from September 2017 to August 2018. Four lactating adult females were radio-collared and tracked for over a period of two months (May-August 2018). The home ranges of the troops were calculated in R using the package 'adehabitatHR'. Spatio-temporal distribution and abundance of rhesus macaques were assessed using grid counts (N=27 days) and roost counts (N=250 days). We estimated the availability of macaque food resources by sampling vegetation plots (N=155), monitoring phenology (N=100 trees), and observing garbage dumps (N=25 dumps, 75 days).

Rhesus macaques gathered food from garbage dumps (57.52%), 30 different plant species, raiding crops and vegetable garden and houses. Foraging activity had a bimodal pattern; in the mornings and evenings. The average home range of macaque troops calculated by MCP was 5 km<sup>2</sup>. The selection of roost sites was strongly influenced by both, the presence of human habitation (closest distance 30m) and garbage dumps (closest distance 0m). We estimate the rhesus macaque population to be around 204 individuals based on grid counts.

Preliminary results show that as expected, activity and diet of rhesus macaques is strongly influenced by human subsidies. It is therefore important to effectively manage garbage and stop provisioning these animals.

**Key words:** Human-rhesus conflict, home-range, provisioning, time activity budget, population estimation

**Project Title** : National Mission on Himalayan Studies- Human Wildlife Conflict

**Principal Investigator(s)** : Dr. S. Sathyakumar, Prof. Qamar Qureshi

**Researcher(s)** : Sayli Sawant (Project fellow)

**Funding Agency** : Sayli Sawant

**Project Duration** : 3 years

## Population status of common leopard, prey and perception of local communities towards human – leopard conflicts in Pauri Garhwal, Uttarakhand

- Gaurav Sonker

Pauri Garhwal region in Uttarakhand is infamous for Human-Leopard Conflict (HLC). The aim of study was to assess the status of leopard and its prey, and to understand perception of local communities towards HLC.

The study was conducted in Ekeshwar block of Pauri Garhwal District from June 2017 to July 2018.

We conducted mark-recapture based camera trapping in a systematic 5 km<sup>2</sup> grid based sampling design and estimated abundance of leopard and prey in an area of 315 km<sup>2</sup> (over 3969 trap nights) from November 2017 to March 2018 within a human-dominated landscape. Majority of the camera traps were deployed near human habitations and sites with previous records of HLC. We carried out semi structured questionnaire surveys (N = 277) to assess socio-economic condition and perception of local communities towards resolving such negative interactions. Relative abundance of prey was assessed using camera trap based photographic capture rates (# per 100 trap nights) through camera traps. We also assessed free ranging domestic dog abundance in an area of (148.5 km<sup>2</sup>) within the same block based on mark-resight method.

Preliminary results of SECR (Spatially Explicit Capture Recapture) indicate that leopard density was 12.73 (SE 4.3) per 100 km<sup>2</sup>. Relative abundance of Indian hare was highest (16.91) followed by wild pig (2.73), barking deer (1.41) and sambar deer (0.10). Based on photo captures, activity pattern of leopard was found to be crepuscular and partly diurnal. Population and density of free ranging dog was estimated as 192 and 1.29 (SE 0.082) per km<sup>2</sup>. Average livestock holding per household was found to be 10.25 (SE 5.44) and annual depredation rate by leopard was estimated as 1.07 (SE 0.22) per household.

Eighty-three percent (50 % ♂ and 33% ♀) of respondents opined that leopard attacks on humans were unprovoked and predatory in nature. Forty-one percent of the respondents were negative towards conservation of leopard and suggested that increased vigilance, putting up streetlights, using carnivore deterrents, clearing shrubs around human habitations will help mitigate HLC.

**Key words:** Abundance, Himalaya, dog, conservation, carnivore.

<b>Project Title</b>	: Human-Wildlife Conflict Resolution Mechanism in the Indian Himalayan Region: Risk assessment, prediction and management through research and community engagement
<b>Principal Investigator(s)</b>	: Dr. G.S. Rawat and Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Gaurav Sonker (Junior Research Fellow)
<b>Funding Agency</b>	: NMHS and Ministry of Environment, Forest and Climate Change, Government of India
<b>Project Duration</b>	: 2016-2019

## Risky home with easy food: Denning of a generalistic and widely distributed carnivore red fox

- Hussain Saifee Reshamwala

Dens are crucial for the survival of all canids. For a meso-carnivore like red fox, denning is of greater importance as they utilize dens all throughout the year for protection, resting and breeding. The red fox known for its generalist and opportunistic behavior and extremely good adaptability to the dynamic anthropogenic changes is the most widespread and successful wild land carnivore.

The study was carried out in Chiktan (Kargil) and Changthang (Leh) areas of Ladakh.

Fox dens were intensively searched from June 2015 to June 2017 using information obtained from sign surveys as well as secondary information from villagers and shepherds. A total effort of 814.5 km was put in to locate the dens. Seven foxes were also radio-collared. Random points were generated in ArcGIS and Multivariate analysis of variance (MANOVA) test was done to find out their denning preferences with respect to random points as well as across the two different study sites.

Most of the dens (56.86%) were found in naturally occurring rocky crevices. Foxes preferred to den on mountain slopes ( $43.70 \pm 3.38$ ) where human disturbances were minimal. Breeding dens had three or more entrances ( $n=8$ ) as alternative routes for the pups to escape when in danger. The red fox showed significant denning preferences with respect to their distances from human settlements, water and road as compared to random points (Pillai's trace = .48,  $F=31.01$  and  $P < .05$ ). The two sites differed only with respect to distance to human settlements ( $P < .05$ ), while the difference between distance to water and road remained insignificant ( $P = .11$  and  $P = .37$ ).

To den in proximity of human settlements seems to be like two sides of a coin. On the one side, this provides easy access to anthropogenic food subsidies without facing competition from other carnivores, while on the other, this exposes the fox and their pups to humans which can be potentially harmful.

**Key words:** *Vulpes vulpes*, Meso-carnivore, Den, Anthropocene, Trans-Himalaya.

<b>Project Title</b>	: Climate Change indicators in the region using Red Fox as indicator species in Ladakh
<b>Principal Investigator(s)</b>	: Dr. Bilal Habib
<b>Researcher(s)</b>	: Hussain Saifee Reshamwala (Senior Research Fellow)
<b>Funding Agency</b>	: National Mission on Himalayan Studies
<b>Project Duration</b>	: 2016-2019

## Abiotic and biotic determinates of species distribution: a case study on snow leopards of Upper Bhagirathi Basin, Western Himalaya

- *Ranjana Pal*

The principle that abiotic factors govern species distributions at large geographical scales is followed by many studies. However, recent research argue that abiotic niche does not explain the entire distribution as a species may be absent in its climatically suitable area due to lack of critical biotic resources. We used seasonal temperature and precipitation variations in a high altitude area (2500-5500m) to study the response of snow leopard with respect to changing habitat conditions. Study was conducted in Upper Bhagirathi basin (UBB) of Uttarakhand. The UBB was systematically surveyed using camera traps since October 2015 (190 sites, 388 sessions, and ~ 54000 trap nights). We used multiseason occupancy models for summer (June to September) and winter (December to March) to estimate the proportion of site utilization ( $\phi$ ) and detection, and tested whether abiotic and biotic factors influence the seasonal site occupancy at two scales (4sqkm and 100 sqkm). Twenty eight abiotic variables (19 bioclimatic, 7 terrain complexity, aspect and ruggedness index) along with five biotic variables (indices of anthropogenic pressures and co-occurring species) were used as covariates. Seasonal density was analysed using secr package in R. Habitat suitability was modelled using MAXENT software. Density estimation revealed that Gangotri National Park in UBB is an important landscape for snow leopard (summer Density =  $1.4 / 100 \text{ km}^2 \pm 0.25$  (SE), unique individuals=17; winter D=  $2.07 \pm 0.4$ , unique individuals=30). Proportions of site utilization increased by 25% and 15% from summer to winter at fine and coarse scale respectively. Blue sheep, a major prey for snow leopard, anthropogenic activities and temperature seasonality influenced snow leopard occupancy at both the scales. Presence-only method (MAXENT) also depicted similar biotic and abiotic factors governing the snow leopard distribution in UBB. Biotic and abiotic factors are equally important in species distribution modelling especially for large ranging carnivores inhabiting high altitude areas. We are increasing efforts towards wider spatial coverage and use of fine scale information on climatic parameters (derived from data loggers).

**Key words:** Multi-season occupancy, climate change, secr package, terrain complexity, MAXENT

<b>Project Title</b>	: Assessment and monitoring of climate change effects on wildlife species and ecosystems for developing adaptation and mitigation strategies in the Indian Himalayan region.
<b>Principal Investigator(s)</b>	: Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Ranjana Pal (Senior Research Fellow), Shashank Arya (Senior Research Fellow), Shagun Thakur (Senior Research Fellow) and Dr. Tapajit Bhattacharya (Scientist)
<b>Funding Agency</b>	: DST- NMSHE
<b>Project Duration</b>	: 5 years

## Modeling present distribution and predicting future spread of two invasive alien plants in Kailash Sacred Landscape- India

- Alka Chaudhary

The main objective of this study was to map the present distribution and predict the future spread of two invasive alien plants, viz., Kala Bansa (*Ageratina adenophora*) and Lantana (*Lantana camara*) within Indian part of Kailash Sacred Landscape (KSL).

The study was conducted in Pithoragarh district of Uttarakhand which forms Indian part of Kailash Sacred Landscape (KSL). This landscape is biologically diverse, ecologically fragile and culturally rich. It is contiguous with the far-western Nepal and Tibet autonomous region (TAR) of China.

Presence locations of Kala Bansa (400) and Lantana (250) along altitudinal gradients of 300 m to 2500 masl. covering various vegetation types were collected. Of these, 80% field data was used for probability distribution modeling and 20% presence data was used to calibrate the results obtained from MaxEnt model. We used the set of 22 predictive eco-geographical variables out of which 19 Bioclimatic variables of present and future (year 2050 and 2070) and three static topographic variables (DEM, Distance from major roads and distance from water bodies) were acquired from worldclim and MODIS datasets. MaxEnt model was used for both the species separately in each time period. The model performance was evaluated using area under curve (AUC) statistics. The predictive maps were compared and identified the change of invasion across these large time scale.

All the maps showing distribution of two invasive alien plants had high predictive accuracy (> 90%). It is predicted that in future Lantana and Eupatorium would colonize more vigorously the dry deciduous and moist facing slopes respectively. The distribution of *Ageratina adenophora* was recorded >2500 masl whereas, in Lantana it was below 1800mts. The potential area that is vulnerable to invasion by Lantana and *Ageratina* comes to 521 km<sup>2</sup> and 856 km<sup>2</sup> respectively.

The increased incidence of invasion in high altitudinal ecosystems is a major threat to the native biological diversity of the region. Four parameters viz. altitude; distance from village/settlements, distance from water bodies were found best predictors of distribution of these alien species. Further spread these species may cause a serious threat to the local biodiversity and a change in ecosystem process of the area.

**Key words:** Invasive species, anthropogenic pressure, modeling, principal component analysis, MaxEnt

<b>Project Title</b>	: Eco-Restoration of Grasslands and Pastures, National Mission for Himalayan Studies (NMHS)
<b>Principal Investigator(s)</b>	: Dr. B.S. Adhikari and Dr. Gopal S. Rawat
<b>Researcher(s)</b>	: Alka Chaudhary (Himalayan Research Fellow)
<b>Funding Agency</b>	: GBPNIHED, MoEFCC
<b>Project Duration</b>	: 2016 – 2019

## Population status of high value medicinal and aromatic plants in Chenab valley, Jammu & Kashmir

- Dr. Suresh Kumar Rana

Medicinal plants have been used historically in traditional healthcare by indigenous communities of the Himalaya. However, increasing population coupled with higher market demand for trade had resulted in population decline of many medicinal plant species. This study aims to identify the high value medicinal plants for assessment of their population in Chenab valley. The valley is situated in Kishtwar and Doda districts of Jammu & Kashmir and covers various catchments of the mighty river Chenab in the north-western Himalaya.

We conducted participatory rural appraisal (PRA) meetings in 16 villages and interviewed 177 informants and 25 herbal healers to document intensity of medicinal plant usage. A total of 47 species including 42 threatened species as per earlier assessment (CAMP 2010) were sampled for their populations in the wild. Total population estimates were done for rare species and stratified sampling was done to estimate the density of relatively abundant species (IUCN 1994, Kaith 2000). A population was considered distinct if it is separated by at least one kilometre from nearest population.

In all, 293 species of medicinal plants are recorded from Chenab valley. Of these, 97 species are used in the local folk medicine to cure 25 ailments using 88 different formulations. Highest number of species is used to cure fever followed by cough, cold, rheumatism and arthritis. Field sampling of threatened species revealed the population size of  $5 \pm 2$  to  $406 \pm 208$ . Among the critically endangered species *Swertia chirayita* wasn't encountered during field sampling whereas *Gentiana kurroa* and *Lilium polyphyllum* were rarest species with a mean population size of only  $5 \pm 2$  and  $6 \pm 3$  individuals. Among endangered species the smallest population size were recorded for *Paris polyphylla*, *Fritillaria roylei*, *Jurinea dolomiaea*, *Picrorhi zakurroa*, *Datisca cannabina*, *Meconopsis aculata* and *Atropa acuminata* with mean population size ranging between  $24 \pm 18$  and  $36 \pm 19$  individuals.

Most of the threatened species are at risk due to their low population sizes and extraction of roots for trade. Only 59% respondents opined that there has been a decline in the availability of wild medicinal plants which is largely ascribed to increasing trade. Further, local communities believe in retaining their traditional rights for utilization of these plants both for trade and traditional healthcare.

**Key words:** Chenab valley; medicinal plants; participatory rural appraisal; stratified density sampling; threatened species.

<b>Project Title</b>	: Assessment of population status for conservation and management of high value medicinal and aromatic plants in Chenab valley J&K
<b>Principal Investigator(s)</b>	: Dr. G.S. Rawat
<b>Researcher(s)</b>	: Suresh Kumar Rana (Senior Research Fellow)
<b>Funding Agency</b>	: Ministry of Environment, Forest and Climate Change, Government of India / G.B. Pant National Institute of Himalayan Environment and Sustainable Development, Almora
<b>Project Duration</b>	: 2016-2019

## Snowmelt timing regulates herbaceous community composition and phenology of alpine plants

- *Rahul Kumar*

High mountain ecosystems are under tremendous pressure due to warming climate, especially Himalaya which is warming faster than global average resulting in early snowmelt. The present study attempts to investigate the impact of snowmelt water on species richness, composition and phenology at treeline ecotone (3200-3300 m elevation) in west Himalaya.

Two sites based on snow cover differences (High snow cover, HSC; Low snow cover, LSC) were selected and further divided into two sub-sites (A and B). In each sub-site, two microsites namely early snowmelt (ESM) and late snowmelt (LSM) with a difference of 4-5 days in snowmelt with 3 quadrats in each, were selected within 50x50m plot. These microsites were repeatedly sampled during the growing period.

Of the total 86 species occurring, 90% species were perennial forbs, 84% were hemicryptophytes and 70% species were native to Himalaya. Species richness and diversity was significantly higher in ESM microsites than in LSM microsites. *Ranunculus* was most dominant in ESM microsites, while *Fragaria* in LSM microsites. The early phenophase was noticed in all the species in ESM than LSM and the timing of different phenophases varied among sites. 10 species were observed in flowering immediately after the snowmelt, while 11 species were in bud development phase in the month of May. Maximum species were in vegetative phase in July (75.6%), while flowering peaked in August (72.1%). Vegetative phase was quite long for *Anaphalis*, *Anemone*, *Danthonia*, *Geranium*, *Oxygraphis*, *Pedicularis*, *Selinum* and *Potentilla*, while budding was observed for the longer time period in *Anemone*, *Geranium*, *Geum*, and *Parnassia*. *Oxygraphis* showed two distinct periods for budding, flowering, and fruiting. Fruiting was absent in *Selinum* and *Anemone*, while it lasted only 1 week for *Danthonia*.

The study shows early snowmelt impact on species richness, plant density and diversity. The study also highlights major changes in herbaceous phenology as compared with past studies.

**Key words:** Climate change, Life form, Phenophase, Growth cycle, Snowmelt, Treeline

<b>Project Title</b>	: Influence of micro-climatic variables on herbaceous plant communities at timberline ecotone of Western Himalaya
<b>Principal Investigator(s)</b>	: Dr. B.S. Adhikari
<b>Researcher(s)</b>	: Rahul Kumar (Junior Research Fellow)
<b>Funding Agency</b>	: National Mission for Himalayan Studies (NMHS)
<b>Project Duration</b>	: 2016-2019

## Status of traditional ecological knowledge among two indigenous ethnic communities of Pithoragarh, Uttarakhand

- Dr. Naveen Chandra Joshi

Aichi Biodiversity Target 18 aims to ensure that traditional knowledge, innovations and practices of indigenous local communities are respected, protected and encouraged. Aligning to this target and in order to fulfil the needs of the national mission on Himalayan ecosystems, several network partners are currently involved in the documentation of traditional ecological knowledge (TEK) across the Indian Himalayan region. This study aims to document the status of TEK related to use of bio-resources of two ethnic communities of eastern Uttarakhand viz., Barpatiya(s) and Van Raji(s).

The study was carried out in the upper parts of Pithoragarh district of eastern Uttarakhand covering Munsyari, Dharchula, Kanalichina and Didihat blocks. Barpatiyas and Van Rajis represent traditional agro-pastoral and hunter-gatherer communities respectively.

Using semi-structured questionnaires, we conducted a total of 512 interviews among Barpatiya (N=285) and Rajis (N=227) to assess the current level of knowledge including TEK in the areas of Health Care System, Food Habits, Farming Practices, Use of Bio-resources, and Traditional Architecture. Informal interviews, group discussions and joint interpretations were also carried out for validation of data acquired. Knowledge richness Index (KRI), Relative Frequency Citation (RFC) and Knowledge Sharing Index (KSI) were used to measure the richness and sharing of knowledge among various gender and age classes. Data analysis was done using SPSS, KYPlot and XLSTAT.

Analysis of data reveals that the overall knowledge related to farming and livestock rearing is still intact with the Barpatiyas. However, this community is losing TEK related to designing of traditional houses (architecture) rapidly. Rajis still retain a considerable knowledge on the uses of bio-resources and they are gaining local knowledge on farming practices. Barpatiyas use as many as 304 species of wild plants and parts of 10 animal species in healthcare systems. Status of TEK in various themes and degree of knowledge transfer among younger age classes have been compared. It was also revealed that Rajis have undergone rapid socio-cultural transformation and lost TEK in recent decades.

Overall TEK in both the communities is declining due to the influence of globalization and rapid socio-economic transformations. The knowledge related to farming (both agriculture and livestock management) is still intact with the Barpatiya community. Rajis exhibit good knowledge of wood processing and carving which can be encouraged for generating livelihood among them.

**Key words:** TEK, documentation, Barpatiya, Raji, knowledge richness

<b>Project Title</b>	: Documentation of Traditional Ecological Knowledge among Indigenous Ethnic Communities of Pithoragarh District, Uttarakhand
<b>Principal Investigator(s)</b>	: Dr. Gopal S. Rawat
<b>Researcher(s)</b>	: Dr. Naveen Chandra Joshi (Project Associate)
<b>Funding Agency</b>	: Department of Science & Technology, Govt. of India
<b>Project Duration</b>	: 2015-2019



## Physico-chemical characteristics of top soil and sub soil across alpine habitats in Gangotri National Park

-Anjali Uniyal and Gunjan Gulati

Study on the nature and properties of soil in subalpine and alpine habitats are important for identification of soil parameters impacting soil microflora and microfauna diversity and function. The aim of the present study was to access the physicochemical properties of top soil and subsoil across alpine habitat. Soil samples (n=21) were collected and analysed for different parameters i.e., pH, electrical conductivity, soil organic carbon, total nitrogen and soil moisture.

The study was conducted across alpine habitat in Gangotri National Park (3100-4000m), Uttarakhand.

Soil samples were collected from 0-5cm for top soil and 15-20cm depth for subsoil from different habitats viz., subalpine conifer mixed forest, subalpine scrubs, alpine alluvial and subalpine broadleaf (birch). Total Nitrogen content, pH and organic carbon was determined by Kjeldahl method, Potentiometric method, and Walkey and Black, 1934 method respectively.

The correlation analysis among different soil parameters showed that organic carbon had significant positive correlation with Nitrogen in both topsoil ( $r = 0.716$ ) and subsoil ( $r = 0.874$ ). The mean value of topsoil Total Nitrogen, Moisture, Organic Carbon, EC and pH, were calculated as 0.72, 33.5, 18.5, 224.5 and 5.8 respectively. The mean value of subsoil Total Nitrogen, Moisture, Organic Carbon, EC and pH, were calculated as 0.46, 35.25, 39.4, 149.7 and 5.7 respectively.

In top soil organic carbon, nitrogen content, EC and pH decreases from subalpine broadleaf (3100m) to alpine scrub (3885m). Therefore, the present study on quantification of Top soil and subsoil is one of the important aspects to understand the health of soil ecosystem.

**Key words:** Soil, physicochemical properties, alpine habitat, organic carbon.

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. G.S Rawat, Dr. V.P. Uniyal & Dr. Gautam Talukdar
<b>Researcher(s)</b>	: Anjali Uniyal & Gunjan Gulati (Project assistant)
<b>Funding Agency</b>	: DST
<b>Project Duration</b>	: 2015-2019

## Anthropogenic influences on site utilization by carnivores in the Great Himalayan National Park, Himachal Pradesh

-Shagun Thakur

Understanding the impact of anthropogenic factors in and around protected areas is essential for conservation and management planning. We studied the influence of human and associated activities on site occupancy and distributions of threatened carnivore species.

The Great Himalayan National Park (GHNP), Himachal Pradesh.

Camera trapping was carried out from March to June 2017 in 2x2 km grids in the *Tirthan* Valley (60 km<sup>2</sup>) and the eco-zone of the *Sainj* Valley (65km<sup>2</sup>). To assess the anthropogenic activities, photographs of humans, livestock and domestic dogs were sorted and photo-capture rates (# capture/100 days) were calculated. Using photo-capture rates of different mammals, principal component scores were extracted to prepare a normalized index. Habitat use intensity was assessed using occupancy analysis framework (2x2km<sup>2</sup>) to determine the influence of habitat types and anthropogenic activities on proportions of site utilization by different carnivores.

Results for the period March to June 2017 (66 sites, 2207 trap nights) revealed that there is high degree of anthropogenic activities (human  $280.99 \pm 89.95$ , livestock  $167.58 \pm 55.26$ , and domestic dog  $7.38 \pm 3.69$ ) in the GHNP. Component bi-plot depicted that two carnivores, common leopard ( $2.98 \pm 0.94$ ) and Asiatic black bear ( $2.01 \pm 0.95$ ) were present along with high anthropogenic activities. Overall proportion of sites utilized by Himalayan brown bear, leopard and black bear were as follows:  $0.43 \pm 0.10$ ,  $0.42 \pm 0.10$ ,  $0.45 \pm 0.06$  respectively. Site utilization was directly proportionate with anthropogenic activities in case of black bear and leopard. In case of Himalayan brown bear, there was a negative association with livestock.

Preliminary findings revealed that there is high degree of anthropogenic activity even inside the core zone of GHNP. We propose to continue the assessment of mammal distribution, abundance and habitat use in a range of human use in the GHNP landscape.

**Key words:** Threatened carnivores, conservation, Photo-capture rate, proportion of site use

<b>Project Title</b>	: National Mission on Himalayan Studies
<b>Principal Investigator(s)</b>	: Dr.S.Sathyakumar
<b>Researcher(s)</b>	: Shagun Thakur-SRF
<b>Funding Agency</b>	: NMHS
<b>Project Duration</b>	: 3 Years

## Analyzing community structure and species distribution of sympatric carnivores in Bhagirathi basin through genetic approach

-Malvika Pandey & Anshu Panwar

Identifying species from the scats is a challenging task particularly in area where sympatric carnivores occurs. However, faecal samples are a reliable and non-invasive source of DNA for molecular scatology. Therefore, we used mitochondrial DNA based marker for identifying the species from scat samples collected from Bhagirathi basin. Subsequently, we will use these samples for estimating population size of the sympatric carnivores and understanding the predator-prey relationship in the Bhagirathi basin.

The study was conducted in the upper catchment of Bhagirathi basin, Uttarakhand.

The study area was intensively surveyed for scat collection. Scats of felid and canid were physically identified in the field on the basis of size (length or diameter), shape (segmented, blunt end, pointed ends etc.) and associated signs (tracks, scrapes). A total of 311 samples of sympatric carnivores were collected in the spring, summer and autumn seasons of 2015 to 2017. The DNA was successfully extracted from 248 samples using the commercially available kit (QIAGEN, Germany). Polymerase Chain Reaction (PCR) based methods were used for amplifying target DNA by using carnivore specific cyt b (146bp) gene primer. All the amplified PCR products were sequenced for the species identification.

DNA was extracted successfully from 248 samples (79.74%) out of 311 samples. 116 samples (46.77%) were successfully sequenced out of 248 samples, which includes Snow leopard (n= 34, 29%), Common leopard (n= 18, 15%), Himalayan wolf (n= 26, 22%), Red fox (n= 20, 17%) and Leopard cat (n=18, 15.5%). Only about 69.38% of Snow leopard and 69.23% of Common leopard scats were correctly identified by Conventional field method.

Our endeavor confirms presence of the species where conventional techniques did not detect species presence appropriately. Thus genetic approach is beneficial for species identification and possibly further species distribution and community structure.

**Key words:** Scat sampling, DNA isolation, cyt b gene, PCR, species identification

<b>Project Title</b>	Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. V.B. Mathur & Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Malvika Pandey & Anshu Panwar
<b>Funding Agency</b>	: Department of Science and Technology(DST)
<b>Project Duration</b>	: 2014-2019

## Adaptive Management of Pollinators through Community Participation in the Spiti Valley, Himachal Pradesh, Indian Trans Himalayan Region

-Mona Chauhan

Decline in insect pollinators is now a well established fact verified by many research findings and scientific reports all over the world. Use of pesticide, changing land use patterns and climate change can affect the nesting, foraging and breeding sites of the pollinators and cause a decline of the pollinator populations. This in turn may ultimately have far-reaching consequences on food security. There is a paucity of attention to pollination services, at all levels of education, including formal and informal education. In this regard, our project aims at i) Assessing the diversity and status of pollinators in Agro-ecosystem along with the risks associated with the loss of pollinators. ii) Identifying the best management practices and technologies to overcome declines in pollinators and iii) Capacity building of different stakeholder groups along with the development of conservation measures and its implementation through hands on training workshops. Present study is being carried out in cold desert mountain Spiti valley of Himachal Pradesh. This area is known for horticulture with a short agricultural growing season that spans from 3-5 months as well as immense pressure of shifting agricultural practises. So far, awareness program has been initiated by working at the local level(Village Panchayat, Block and District) and by building capacities of local communities, youth, school children and baseline agencies by conducting workshops, conservation awareness program and participatory rural appraisal approach for the development and application of methodologies for mitigation policy measures through multi-stakeholder scenario building. Innovative approaches and curriculum material, as a basis for scaling-up the building of capacity to manage insect pollinators have been developed. Destruction of natural habitats due to alteration in agriculture conventional practices (increased mechanization, mono culture, and high yielding crops lack of knowledge about the appropriate use of pesticides) has been observed. The transformation of agriculture from traditional mixed crop farming to high value cash crop farming in recent years has led to an increase in mono-crop agriculture, reducing the food sources for natural insect pollinators also farmers are switching on a large scale to the cultivation of cash income-generating fruit crops and off-seasonal vegetation.

**Key Words:** Pollinators, Conservation, Community Participation, Capacity building

<b>Project Title</b>	: "Assessment and Conservation Practices of Pollinators through Community Participation in the Indian Trans Himalayan Region: Climate Change Perspective"
<b>Principal Investigator(s)</b>	: Dr. V.P Uniyal
<b>Researcher(s)</b>	: Mona Chauhan, Project Biologist
<b>Funding Agency</b>	: MOEFCC
<b>Project Duration</b>	: 3 Years

## Spatial patterns of Human-Elephant Conflict in Dooars landscape of North Bengal

-Suraj Kumar Dash

Research on the spatial patterns of human-elephant conflicts (HEC) is of utmost importance to understand the underlying mechanism of such interactions, i.e. major land use changes and prominent ecological drivers. The Dooars landscape of North Bengal has undergone rapid change in major land use type due to rise in anthropogenic activities and fragmentation of wildlife habitats leading to intense conflicts between humans and Asian elephants (*Elephas maximus*).

We analyzed data maintained by the West Bengal Forest Department on human deaths and injuries caused by elephant between 2000-2016 to understand spatial and temporal patterns of HEC, frequency and distribution. We used a total of 14 predictor variables (open source and remotely sensed data) and conflict locations (N = 234) to model human-elephant conflict risk using Maxent presence only models. Major land use changes were assessed for this region from 2008 to 2018 using satellite imageries in Arc GIS.

Based on a grid based design of 5 km<sup>2</sup> and 25 km<sup>2</sup> resolution, the main spatial predictors of HEC were identified as altitude and distance from protected area (negatively related) and annual mean precipitation, area under forests, tea plantations, agriculture (positively related). Based on the 2018 imagery it was found that forest area had increased by 446 km<sup>2</sup> within 10 years (2008-2018) and the annual rate of change was 12%. Area under agriculture had reduced by 128 km<sup>2</sup> with an annual (-) rate of change of 2.5%. Area under tea plantation declined by 307 km<sup>2</sup> with an annual (-) rate of change of 12% whereas area under human settlements increased by 61 km<sup>2</sup> with an annual (+) rate of change of 44%. Hotspots of HEC were identified in an east-west direction primarily around protected areas, tea plantations and along major riverine corridors.

Our analytical approach can be replicated for other species in sites with similar issues of HEC. The hotspot maps of conflict risk will help in developing appropriate mitigation strategies such as setting up early warning systems, restoration of wildlife corridors especially along dry river beds, using deterrents and barriers for vulnerable zones.

**Key words:** Habitat, land use, spatial model, tea plantation, wildlife corridors.

<b>Project Title</b>	: Human-Wildlife Conflict Resolution Mechanism in the Indian Himalayan Region: Risk assessment, prediction and management through research and community engagement
<b>Principal Investigator(s)</b>	: Dr. G.S. Rawat and Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Suraj Kumar Dash (Junior Project fellow)
<b>Funding Agency</b>	: NMHS and Ministry of Environment, Forest and Climate Change, Government of India
<b>Project Duration</b>	: 2016-2019

## Preliminary investigations on HWC in Chamba region, Himachal Pradesh

-Nitin Bhushan

Chamba district of Himachal Pradesh falls under Pir-panjal mountain range in the north-western part of the Indian Himalayan region. In recent years, local communities of this region have reported increased negative interactions with wildlife especially livestock depredation by carnivores and crop damage by ungulates. Thus we aim to assess relative abundance of large mammals, extent and patterns of conflicts and perception of local communities toward resolving human-wildlife conflicts (HWC).

The present study was conducted in Kugti and Tundah Wildlife Sanctuaries of Himachal Pradesh between August 2017-June 2018.

Relative abundance of carnivores (Himalayan brown bear, Asiatic Black bear, Common leopard, Red fox and Himalayan yellow throated marten) and Ungulates (Himalayan goral, Asiatic ibex, Himalayan tahr and Musk deer) were estimated using camera trap (n=23) with 1280 trap nights. All camera traps were systematically distributed within the study area (405.49 km<sup>2</sup>) by superimposing a (2×2) km grid, and deploying at least one camera trap within each accessible grid. Questionnaire surveys (n = 276) were carried out across villages of kugti and tundah (n=14) Wildlife Sanctuaries to assess HWC and perception of local communities toward wildlife.

The photo capture rates per 100 trap nights were highest for Himalayan brown bear (n=7.42) and Asiatic black bear (n=1.25) in the study area. It was low for Common leopard (n=0.44) and Red fox (2.04). Himalayan brown bear and Asiatic black bear had the highest photographic capture rates (n = 7.42) and (n = 1.25) per 100 trap nights respectively within the study site. Common leopard and Red fox had relatively low photographic capture rate (n=0.44) and (n=2.04) than Himalayan brown bear. The average livestock depredation by Himalayan brown bear were estimated 26 (SE=1.91) and 6 (SE=0.9) for Asiatic black bear respectively. The negative attitude towards Himalayan brown bear, Asiatic black bear, Common leopard and Tibetan wolf was high (>84%).

Preliminary results indicates negative interactions between local communities and wildlife, and extremely negative attitude towards carnivores possibly due to economic loss.

**Key words:** Pir-panjal range, relative abundance, questionnaire survey, himalayan brown bear, livestock depredation

<b>Project Title</b>	: Human-Wildlife Conflict Resolution Mechanism in the Indian Himalayan Region: Risk assessment, prediction, and management through research and community engagement
<b>Principal Investigator(s)</b>	: Dr. G. S. Rawat & Dr. S. Sathyakumar
<b>Researcher(s)</b>	: Nitin Bhushan, Project fellow
<b>Funding Agency</b>	: The Ministry of Environment, Forest and Climate Change (MoEFCC)
<b>Project Duration</b>	: 2016-2019

## Technological Interventions to Enhance the Livelihood of Mountain Communities

-Charuhas S. Dali

The aim of the project is to monitor and evaluate various activities regarding technological interventions conducted by the institutions under the TIME:LEARN Programme.

Total 20 projects are being implemented by various organizations and scientific institutions in the three Western Himalayan states of Uttarakhand (8), Himachal Pradesh (8) and Jammu and Kashmir (4).

Indicators were identified for the thrust areas including Sustainable Agriculture, Forest use & Conservation, Rural Engineering & Technology, Water Resource Management, Disaster Management, Gender Sensitive Development and Harnessing & Conserving Renewable Energy. Based on the indicators the projects are being evaluated, monitored and gaps are being identified.

The results of the survey showed that the various activities under the TIME: LEARN programme, are helping the mountain community to mitigate their problems. Transfer of technology such as polyhouse technique is helping the vegetable growers to grow off season vegetables as well as get better yield than open farming practices. Up gradation of traditional river ropeways in the remote villages, which earlier restricted the mobility of women folks as well as old age people, is now proving to be better alternative for transportation. It also helped to minimize their efforts along with the certainty of facing accidents while crossing the river. Technologies such as water harvesting pits and bee hive installation are supporting the mountain agriculture to get better yield.

The monitoring and evaluation of the project activities is under process. However, it can be concluded that the programme should expand and focus should be given on specific problems like climate change, water resource management, soil erosion, gender development and agro-forestry. The initiative is helping to build a bridge between the traditional knowledge and skill of mountain community with modern technologies.

**Key words:** Western Himalayas, technology intervention, sustainability, networking, community participation

<b>Project Title</b>	: Dissemination and evaluation of technologies through networking of various institutions and organizations of Western Himalaya
<b>Principal Investigator(s)</b>	: Dr. Ruchi Badola & Dr. S. A. Hussain
<b>Researcher(s)</b>	: Charuhas S. Dali/ Senior Research Fellow
<b>Funding Agency</b>	: Department of Science & Technology
<b>Project Duration</b>	: February 2020

## Response of subalpine and alpine plant communities to experimental warming

-Chirag Girdhar

Alpine ecosystems are most sensitive to climate change. However, climate change impacts on the structure and composition of alpine plant communities have not been studied in detail. This study aims to investigate the influence of experimental warming on the structure and functioning of alpine ecosystems.

The study was carried out in Gangotri National Park, Uttarakhand, Western Himalaya.

We used 10 Open top chambers (OTCs) for experimental warming at various sites in subalpine and alpine areas of GNP. The setup was designed to increase the air temperature within the expected future scenarios of climate change. Vegetation composition, biomass, phenology and soil physico-chemical properties were investigated following standard methods. Responses of the alpine vegetation in terms of structure and functioning to the warming condition were monitored and compared with the natural conditions.

Air temperature inside the OTC was elevated by 1.8°C, which is well within the projected scenario of climate change. After 2 years of warming, the densities of the species was found slightly low inside OTC as compared to the controlled plots but biomass production was increased by 34% inside the OTC with *Nepeta discolor* and *Geranium himalayense* having a maximum contribution of 28.38% and 24.02%, respectively. The study revealed that the species growing inside the OTC have 18.2% higher water content as compared to a natural condition. An increase in the total soil Nitrogen content was found inside the OTC as compared to natural conditions after 2 years of warming. High positive correlation (0.01 level) of biomass production with soil microbial activity, soil moisture, and total Nitrogen was observed in altered climatic condition inside OTC.

The OTC based experimental warming was found as an excellent tool to monitor responses of alpine ecosystems. The present study reveals that two-year warming resulted in increased above ground productivity, which may be due to high soil microbial enzymatic activity and increased soil nitrogen content. Further, data on the plant responses to experimental warming will be collected in the next growing seasons, correlated with the climatic, and soil physio-chemical properties in altered and natural conditions.

**Key words:** Open Top Chamber, Phenology, Biomass production, Western Himalaya

<b>Project Title</b>	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
<b>Principal Investigator(s)</b>	: Dr. Gopal S. Rawat and Dr. Gautam Talukdar
<b>Researcher(s)</b>	: Chirag Girdhar (NMHS-Fellow)
<b>Funding Agency</b>	: DST
<b>Project Duration</b>	: 2014-2019



## Status of agriculture and crop landrace diversity in Pithoragarh district, Uttarakhand

-Rishabh Srikar

Agro-ecosystems in Himalaya are vulnerable to multiple factors including climate change, human outmigration and preference for high yielding varieties. Especially, the traditional crop varieties / landraces developed over many generations considering the local environmental conditions are facing the risk of extinction. This study aims at understanding the diversity of traditional crops and factors influencing the agro-systems in Pithoragarh district of Uttarakhand. The study was conducted in four administrative blocks of Pithoragarh district, Uttarakhand which is bordered on the east by Nepal and north by Tibetan Autonomous Region of China. The agriculture here is mostly rain-fed and is driven by subsistence rather than economy. The study was conducted through questionnaire survey (n=151) in 31 villages across 4 administrative blocks of the district to understand the trends in agriculture, crop diversity, socio-economy of the farmers, availability of basic amenities (e.g., mode of transportation, school, healthcare, distance from market etc.). A total of 29 major crops are cultivated in the study area, of which, rice, wheat and finger millet show highest landrace diversity (n=51, n=14 and n=9 respectively). It was found that as many as thirty crops have been abandoned at varying intensities during last 20 years. The area under agricultural land use has declined by 19% in the last 10 years and there is an overall decline of 28% in area under cultivation. The respondents perceived climate change as the major threat to agriculture followed by wildlife depredation, decline in workforce, access to markets, and pest damage. Decline in area under agriculture and loss of crop diversity and landrace diversity indicate alarming trends in agriculture in the study area. Therefore, policy level interventions based on scientific knowledge is required to prevent the cascading effects of aforementioned factors on the food security and sustainable livelihood of the local community.

<b>Project Title</b>	: Conservation of indigenous crop varieties and vulnerability assessment of agro-ecosystem in Pithoragarh district, Uttarakhand
<b>Principal Investigator(s)</b>	: Dr. G.S. Rawat
<b>Researcher(s)</b>	: RishabhSrikar (Intern); Nehru Prabakaran (Himalayan Research Associate/ DST-INSPIRE Faculty)
<b>Funding Agency</b>	: MOEFCC (NMHS Fellowships)
<b>Project Duration</b>	: 2016-2019

## Valuation of Ecosystem Services (ESS) Flowing from a Community Managed Forest in Dhauladhar Range, Himachal Pradesh

-Dr. Anjali Uniyal

Ecosystem service (ESS) assessments help to understand numerous contributions of nature. It is very important in planning policies for areas such as the Himalayas, where rural livelihood is directly dependent on natural resources. Traditionally, lifestyle of villagers has helped in the sustained flow of ESS. However, habitat degradation, over-exploitation and climate change may affect these negatively. Lack of adequate knowledge regarding ESS flowing from them is a major gap. Recognizing this, the present study was conducted to identify key ESS used by the local people and an economic valuation of the provisioning services flowing from forest ecosystem.

Bohl spring-shed (BSS), in the Dhauladhar range (Himachal Pradesh) is the pilot study site. This is the first example of Payment for water services in western Himalaya.

Focus group discussions (n=5) and semi-structured interviews (n=66, 100% sampling) were conducted to collect data. Stakeholders identified 25 ESS, as per Common International Classification of Ecosystem Services. Total economic valuation framework was followed for valuation of provisioning services.

Provisioning services have high significance for the villagers (100% respondents). Mean value of nine provisioning services was estimated at Rs.121, 987.42± 6494.02 HH<sup>-1</sup>Year<sup>-1</sup>. It was found that ca. 90% of the net values of ESS flowing are crucial for the sustainable livelihood of villagers while ESS in the form of drinking water (Rs.784,040 Year<sup>-1</sup>) is more important for the downstream town. However, degradation of forest due to *Ageratina eupatoria* and *Lantana camara* infestation has caused decreased grass fodder availability (9% of the total ESS value) and might also affect the flow of other services in near future.

Effective management and long term monitoring of the BSS is must for the sustenance and continued flow of ESS.

**Key words:** Spring-shed, Himalaya, PES, Valuation, Provisioning services

<b>Project Title</b>	: Conservation and sustainable management of land and natural resources (NMHS)
<b>Principal Investigator(s)</b>	: Dr. Gopal S. Rawat
<b>Researcher(s)</b>	: Dr. Anjali Uniyal/Himalayan Research Associate
<b>Funding Agency</b>	: GBPNIHED, MoEFCC
<b>Project Duration</b>	: 4th July 2016 – 3rd July 2019

## Long-term environmental and ecological monitoring in Sikkim Himalaya

-Rishi Kumar

Long-term environmental and ecological monitoring in Sikkim Himalaya -Rishi Kumar The Himalayan region represents one of the hotspots of biodiversity and highly fragile environments. This region is also data deficient and lacks baseline data on ecosystem health and anthropogenic pressures. This calls for a concerted effort in collecting baseline info on various aspects of long-term environmental monitoring. This study aims at establishing a system of long-term environmental and ecological monitoring sites in Teesta basin, with the objectives of developing a comprehensive environmental monitoring protocol; suggesting an institutional mechanism, and generating baseline data on key environmental parameters. The study is being carried out in Teesta basin, Sikkim Himalaya covering an altitudinal gradient of 300 to 5300 masl with a varied anthropogenic pressure gradient. Using a detailed land-use and land-cover map of Teesta basin and following a broad altitudinal and anthropogenic gradients, 24 sites for environmental monitoring have been selected within the representative area. At each site a 1-hectare permanent plots and multiple random sites have been selected for vegetation monitoring. We used 20m x 20m quadrats for tree species, nested plots of 5m x 5m for shrubs and saplings, and 1m x 1m for herb assessment at each site. Fauna and galliformes are being monitored using trails and transects. Critical long-term monitoring sites have also been identified which include plots in the transition zone of broad forest categories, sites sensitive to grazing, fire, pollution and extraction. A more intensive monitoring would be performed at these sites particularly for weed cover, High-Value Medicinal Plants, regeneration of key species and species which are sensitive to climate and anthropogenic pressures. Out of the 24 sites, 20 sites were found sensitive to either anthropogenic pressure or climate change. Future projections based on the intensive monitoring would also be essential in understanding changes in forest type over time and across anthropogenic pressure gradients. This is the first long-term environmental and ecological monitoring program in Eastern Himalaya. It will feed into a larger database for the Indian Himalayan Region and can integrate with National I-LTEO monitoring.

**Key words:** Anthropogenic pressure, flora, fauna, Teesta basin

<b>Project Title</b>	: Long-Term Environmental and Ecological Research Initiative in Sikkim Himalaya
<b>Principal Investigator(s)</b>	: Dr. G. S. Rawat
<b>Researcher(s)</b>	: Rishi Kumar
<b>Funding Agency</b>	: National Mission on Himalayan Studies, GBPNIESD
<b>Project Duration</b>	: 1st July 2016 and 30th June 2019

## Linking communities with conservation in Maenam wildlife sanctuary, Sikkim: Opportunities and challenges

-Paridhi Jain

Sikkim has set aside 56.69 percent of forest area as PA Network. While state has a strong policy focus on conservation of biodiversity, significant credit for protection of this biological heritage is also attributed to cultural values and tolerance of people. Changing paradigms of market demands and resource utilization are affecting the interface between humans and biodiversity. In this context, present study was conducted as part of management planning exercise in Maenam wildlife sanctuary located in South Sikkim.

The study aimed at understanding the current interaction of fringe area communities with the sanctuary in terms of resource use and human wildlife conflict, its implication in the management and find out ways to strengthen the linkages of the communities for long-term conservation of this area.

12 villages covered under 9 EDCs were studied through a sample 20 % of total households. In total 170 households were interviewed using open-ended and close-ended questionnaires to gather information regarding their socio economic status, resource use, human wildlife conflict, attitudes towards conservation and related issues. Focus group discussions were conducted with forest staff and officials to understand their perceptions about management issues and current situation of community involvement in sanctuary management through Eco development programmes.

Results showed that the communities are more dependent on fuelwood species like *Alnus nepalensis*, *Castanopsis sp.*, *Engelhardtia acerifolia* and fodder species like *Ficus memarolis*, *Ficus cunea*, *Thysanolaena maxima*. The extent of dependency is higher in remote and poor villages. Human wildlife conflict was found to be mostly in the form of raiding followed by livestock killings. The major species involved in conflict are Asiatic black bear and Macaque. The current eco development plan is very sporadic and involvement of people is very opportunistic.

Hence, a holistic approach involving sustainable utilization of NTFPs with also focusing on human wildlife interface and ecotourism initiatives is required. The current study helped in formulation of the management plan of Maenam WLS and aims to replicate the same work for other PAs of the state.

**Key words:** forest resource, holistic, management

<b>Project Title</b>	: Wildlife management planning for protected areas of Sikkim
<b>Principal Investigator(s)</b>	: Ajay Srivastava
<b>Researcher(s)</b>	: Paridhi Jain/Project Biologist
<b>Funding Agency</b>	: Sikkim forest department
<b>Project Duration</b>	: 2017- 2018