4th HIMALAYAN RESEARCH SEMINAR

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

4th

HIMALAYAN
RESEARCH SEMINAR

21st August 2019

Programme & Abstracts

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Programme

SEMINAR CHAIRPERSON
Shri. B. S. Bonal, Former ADG (WL), MoEFCC & Member Secretary, NTCA

INAUGURAL SESSION

0915 – 0920 h	*Welcome*	*Dr. S. Sathyakumar, Scientist - G*
0920 – 0930 h	*Opening Remarks*	*Dr. G. S. Rawat, Dean, FWS, WII*
0930 - 0645 h	*Inaugural Address*	*Shri. B. S. Bonal, Seminar Chairperson*

TECHNICAL SESSION – I

Chair: Dr. S. Sathyakumar, Scientist – G
Co-Chair(s): Dr. K. Ramesh, Scientist – E
 Sh. Salvador Lyngdoh, Scientist – D

Poster Presentations (Mixed Bag): Speed Talks

Time	Title	Presenter(s)
0945-0948 h	How correct are field identification of carnivore scat: A case study from the Western Himalaya.	*Anshu Pawar & Gunjan Gulati*
0948-0951 h	Preliminary assessment and conservation of Insect Pollinators through citizen science in Himachal Pradesh and Uttarakhand.	*Mona Chauhan*
0951-0954 h	Interactions of forest dwelling small and meso carnivores in Manas National Park, Assam.	*Urjit Bhatt*
0954-0957 h	Livelihoods and grazing patterns of transhumant and other pastoral communities in Darma valley, Kailash Sacred Landscape, India.	*Rishabh Srikar & Udita Garbyal*
0957-1000 h	Assessment of capacity building and training needs of key stakeholders in biodiversity conservation in Lahaul and Pangi Valley, Himachal Pradesh.	*Meghma Ghosh & Bhawna Pandey*
1000-1003 h	Identifying and delineating high conservation value areas across different ecosystems in and Pangi Valley, Himachal Pradesh.	*Nidhi Singh & Shiv Yadav*
1003-1006 h	An Experimental approach to assess the impact of climate warming on lichen growth and physiology in IHR.	*Chirag Giridhar*
1006-1009 h	Orchid conservation initiative through community participation in Gori Valley, Kailash Sacred Landscape, India.	*Soni Bisht*
1009-1012 h	Movement and ranging patterns of Rhesus macaques in Chandrabani, Dehradun.	*Sayli Sawant*
1012-1015 h	Human-carnivore conflict in Chamba district, Himachal Pradesh: Understanding peoples' perception and reality.	*Nitin Bhushan*
1015-1018 h	Co-occurrence of human, leopard and perceived risk in a shared landscape of North-East India.	*Suraj Kumar Dash*
1018-1021 h	Pragmatic approach to vulnerability assessment of local community in Trans-Himalaya.	*Dharani M, Sipu Kumar, & Kalzang Targe*
1021-1024 h	Assessment of selected important Medicinal and Aromatic Plants in Lahaul and Pangi, Himachal Pradesh, India.	*Rupali Sharma, Monika Sharma, Manisha Mathela & Himanshu Bargali*
1024-1027 h	Current status on diversity and distribution of Odonates (Insecta:Odonata) in the Indian Himalayan region: An overview	*Shuvendu Das*

Oral Presentation
CONSERVATION STATUS & ECOLOGICAL PATTERNS

Time	Title	Presenter(s)
1030-1045 h	Assessment of key mammal species in four protected areas of Himachal Pradesh, India	*Ankita Bhattacharya,* Senior Research Fellow
1045-1100 h	Conservation prospects of threatened and newly discovered mammals of Bhagirathi Basin, Uttarakhand, India	*Ranjana Pal*, Senior Research Fellow
1100-1115 h	**Tea**	
1115-1130 h	Small carnivore community along elevation gradient in the Great Himalayan National Park, Himachal Pradesh	*Meghna Bandopadhyay,* Junior Research Fellow
1130-1145 h	Ghost hunting: Investigating the movement pattern of *Nanorana vicina* in Himalayan Torrent Stream	*Swati Nawani,* Project Assistant
1145-1215 h	**Discussion & Remarks by Chair and Co-Chairs**	

TECHNICAL SESSION – II
VEGETATION AND HABITAT MONITORING

Chair: Dr. B. S. Adhikari, Scientist-F
Co-Chair(s): Dr. Malvika Onial, Scientist-D
 Dr. Amit Kumar, Scientist-C

Time	Title	Presenter(s)
1215-1230 h	Vegetation structure and composition: Long-term ecological monitoring across environmental gradients in Sikkim Himalaya	*Dr. Rishi Kumar*, Project Scientist
1230-1245 h	Is climate warming converting alpine soil into net carbon source?	*Pankaj Tiwari,* Project Fellow
1245-1300 h	Influence of snowmelt water on structural and functional attributes in alpine meadows	*Rahul Kumar,* Junior Research Fellow
1300-1315 h	**Discussion & Remarks by Chair and Co-Chairs**	
1315-1415 h	**Lunch**	

TECHNICAL SESSION – III
CLIMATE CHANGE, VULNERABILITY AND ADAPTATION

Chair: Dr. Ruchi Badola, Scientist-G
Co-Chair(s): Dr. Gautam Talukdar, Scientist-E
 Dr. Navendu Page, Scientist-C

Time	Title	Presenter(s)
1415-1430 h	Escalators to extinction: Decoding climate-induced future trajectories for the Himalayan Snow Trout	*Aashna Sharma,* Senior Research Fellow
1430-1445 h	Mapping the potential effect of climate change on the distribution of Himalayan Pit Viper (*Gloydius himalayanus*)	*Naitik Patel,* Junior Research Fellow
1445-1500 h	Dwindling traditional knowledge and livelihood vulnerability of an agro-pastoral community in Western Himalaya	*Dr. Naveen C. Joshi,* Project Associate

1500-1515 h	Comparative assessment of adaptive capacity and vulnerability of Western and Eastern Himalaya	*Prashant Tariyal,* Project Biologist
1515-1530 h	Quality of life: An approach to explore nexus between human well-being and ecosystem services in the Bhagirathi river basin	*Tanvi Gaur,* Senior Research Fellow
1530-1545 h	**Discussion & Remarks by Chair and Co-Chairs**	
1545-1600 h	**Tea**	

TECHNICAL SESSION – IV
HUMAN –WILDLIFE CONFLICT

Chair: Dr. V. P. Uniyal, Scientist-G
Co-Chair(s): Dr. Gopi, G.V., Scientist-E
 Dr. C. Ramesh, Scientist-C

Time	Title	Presenter(s)
1600-1615 h	Assessment of human-black bear conflicts in agro-pastoral mountainous landscape of eastern Himalaya	*Abhisek Chettri,* Project Fellow
1615-1630 h	Relative abundance of major mammalian prey: Implications for human-wildlife conflict management in human dominated landscape of western Himalaya	*Gaurav Sonkar,* Project Fellow
1630-1645 h	Perceived risk from large predator and efficacy of non-lethal deterrent as a potential tool to resolve human carnivore conflicts	*Pooja Chaudhary,* Project Fellow
1645-1700 h	**Discussion & Remarks by Chair and Co-Chairs**	

CONCLUDING SESSION

Time	
1700-1715 h	**Concluding Remarks by the Seminar Chairperson**
1715-1730h	**Vote of Thanks -** *Dr. K. Vishnupriya,* Scientist-C

How correct are field identification of carnivore scat: A case study from the western Himalaya

-Anshu Panwar & Gunjan Gulati

Aim: To identify carnivore species from faeces collected from the western Himalaya region.

Locations: The study was conducted in Uttarkashi district, Uttarakhand and Bharmour Forest Division of Chamba district, Himachal Pradesh.

Methods: The scat samples were collected from Uttarakhand (n= 416) and Himachal Pradesh (n= 254), respectively covering three seasons (spring, summer and autumn) from October 2015 to June 2019. Identification of species on the basis of physical appearance and associated signs were done in *in-situ* conditions.

DNA was extracted by using commercially available kit (QIAGEN, Germany). Polymerase Chain Reaction (PCR) based method were used for amplifying target DNA by using carnivore specific cyt b (430bp) and control region (340bp) gene primers. All the amplified PCR products were sequenced for species identification.

Results: Of the total, 670 scat samples DNA were extracted from 635 fecal samples (n= 395 Bhagirathi basin and n= 240 Bharmour Division) and used an unambiguous mtDNA analysis to differentiate scats from those of sympatric carnivores. A total of 35 samples were discarded before extraction because of their poor quality. We successfully amplified DNA from 76.57% (n=219 out of 286) of the extracts collected from Bhagirathi, and 73% (n=175 out of 240) collected from Bharmour. Results show that scat samples were of Himalayan brown bear (n=190), Snow leopard (n=55), Common leopard (n=49), Grey Wolf (n=34) and Red fox (n=33) and Leopard cat (n= 33). The analysis for remaining samples (n=109) are in progress. Only about 76% of Snow leopard, 74% of Common leopard and 78% of Himalayan brown bear scats were correctly identified by conventional/morphological field method. Also 22% of brown Bear scats remain unidentified in field because of poor physical appearance of sample. Success rate of conventional method is 84.5%.

Conclusions: In general, Field identification of carnivore scat was correct for 85% cases only.

Key words: Molecular analysis, sympatric carnivores, mtDNA, IHR, PCR, species Identification

Project Title	: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region
Principal Investigator(s)	: Dr. S. Sathyakumar and Dr. V. B. Mathur
Researcher(s)	: Anshu Panwar and Gunjan Gulati, Project Assistants
Funding Agency	: DST - NMSHE
Project Duration	: 31-3-2015 to 31-3-2019

Preliminary assessment and conservation of Insect Pollinators through citizen science in Himachal Pradesh and Uttrakhand

-Mona Chuahan

Title: Preliminary assessment and conservation of Insect Pollinators through citizen science in Himachal Pradesh and Uttrakhand

Aim: Pollination is an example of a tangible ecosystem service with direct consequences for human food production, as well as indirect consequences through provision of many other ecosystem services (supporting services, provisioning services, regulating services and cultural services). Various studies have been proven that there is a decline in insect pollinator's population due to climate change, use of chemicals, increased inorganic farming and land use changes. But there is a lack of comprehensive data on species loss due to previously discussed brute causes of decline. Assessment of diversity and distribution of insect pollinators and identification of causes of decline in insect pollinator's population with capacity building of local community/youth/ line agencies/ school children for the conservation of insect pollinators.

Location: This study has been initiated in Himachal Pradesh and Uttarakhand of the Indian Trans Himalayan region.

Methods: Pollard transect methods has been followed for butterfly (Lepidoptera) assemblages. Bush beating, netting and hand picking were used for Coleoptera, Hymenoptera, Diptera and Hemipetra. Direct encounters were also taken into account. Citizen Science approach has been followed for awareness and conservation.

Preliminary Results: We have done faunal surveys for insect pollinators in Lahaul and Spiti district of Himachal Pradesh and Pithoragarh district of Uttarakhand. A total of 63 species of pollinators consists of 6 species of (Hymenoptera), 34 species of (Lepidoptera), 14 species of flies (Diptera), 5 species of beetles (Coleoptera) and 4 species of (Hemiptera). Identification work is in progress. Among the insect pollinators, Lepidoptera found to be more diversified taxa. We have identified various detrimental practices in study area such as monoculture farming, increased grazing and mowing of pasture lands, introduction of invasive species, honey hunting, introduction of Apis Mellifera, increased cases of pests predators, diseases, and parasites, augmented use of chemical Pesticides, fertilizers and growth stimulators in agriculture and horticulture fields. Total 18 capacity building programmes/hands on training/school awareness programme have been conducted in Lahaul and Spiti district of Himachal Pradesh, Chamoli and Pithoragarh district of Uttarakhand. Total 463 individuals have been involved in programme to educate about conservation and importance of Pollinators in study area.

Keywords: pollinators, climate change, diversity, Indian Trans Himalayan region

Project Title	:	Assessment and Conservation Practices of Pollinators through Community Participation in the Indian Trans Himalayan Region: Climate Change Perspective
Principal Investigator(s)	:	Dr. V.P Uniyal
Researcher(s)	:	Project Biologist
Funding Agency	:	MoEFCC - NMHS
Project Duration	:	2018-2020

Interactions of forest dwelling small and meso carnivores in Manas National Park, Assam

-Urjit Bhatt

Species interaction plays a vital role in structuring communities by stimulating behavioral responses in temporal niche, thereby affecting the sympatric associations. We assessed clouded leopard status, relative abundance indices (RAI), road use patterns and activity rhythms of small & meso carnivores to understand temporal overlaps between sympatrids and moonlight influence on dominant & subdominant mammalian assemblages.

The study was carried out in tropical semi-evergreen forests of Manas National Park.

Camera traps (n=456) were deployed in a 1×1 grid-size over a period from April 2017 to May 2019. The RAI was calculated as the sum of all detections, divided by the total number of trap nights. Clouded leopards were identified by distinctive cloud-like pelage pattern. Activity rhythms were classified as diurnal, nocturnal, crepuscular, and cathemeral. Activity patterns and temporal overlap were determined using kernel density curves and overlap coefficients, respectively. RAI was used to assess the effects of roads (tourist and logging or animal trail) on abundance of small & meso carnivores. Moon phases were classified as new, waxing, full, and waning.

A total of 13 species with 1636 independent records of small & meso carnivores were recorded over 10960 trap-nights. Twelve individuals of clouded leopards were identified out of 21 camera-trapped photographs. A high degree of temporal overlap [Δ_4=0.91 ($\pm$0.02)] with varying activity peaks were observed among most sympatrids. Clouded leopard, leopard cat & civets were nocturnal, whereas yellow-throated marten and mongooses were diurnal. Diurnal carnivores' abundance was affected by tourist roads (t=-2.17, p<0.05). Moon phase was not correlated with activity of large carnivores, large-small prey, and small felids. Activity of viverrids was negatively influenced by lunar cycle ($_{correlation}$ r=-0.243, p<0.01).

The dominant species activity was least affected by lunar cycle, while subdominant species activity was lunarphobic perhaps to increase foraging efficiency or as an antipredator strategy.

Keywords: Tropical forest, carnivore, activity pattern, moonlight, lunar phobic, niche-overlaps

Livelihoods and grazing patterns of transhumant and other pastoral communities in Darma valley, Kailash Sacred Landscape, India

-Rishabh Srikar

Aim- Pastoralism is integral to the livelihood of ethnic communities, inhabiting the villages of Darma valley, Dharchula block, Pithoragarh (Bhotia, Anwals) and those coming from outside (Gaddi), having shaped traditional socio-economies and ecology of the valley. Herders and their livestock are dependent on alpine rangelands to sustain their nomadic and transhumant lifestyles and have traditionally made use of established grazing routes. Consequently, potential anthropogenic pressures along these routes need to be documented and studied to understand the scope of ecological changes in these fragile mountain ecosystems. The study was aimed at delineating herding routes, elucidating data on grazing and studying economics of pastoral enterprise.

Location- Darma valley ranging from 1627 – 3465 masl (36 km from Dharchula, Sobla – 30.05259^0N 80.58784^0E to Sipu - 30.30997^0N 80.49188^0E) block Dharchula, dist. Pithoragarh.

Method- Structured and semi-structured interviews were conducted amongst herders and livestock owners of Darma valley (Bhotia ~ 50%, Anwals ~ 49%, Gaddi ~ 1%). Major rangelands accessed and halting stops along the routes were documented with their use to determine points of high pressure on alpine vegetation. Equity sharing within herders based on livestock ownership and contribution of *Cordyceps* and medicinal-aromatic plants (MAP) extraction to household income was explored.

Result- Altogether 49 halting points from Tanakpur to Upper Darma were identified. Darma valley houses 20 major halting points (use percent: Nagling – 51.79%, Dugtu – 33.93%, Go – 32.14%) and five major alpine pastures along five major summer herding routes (routes most accessed by respondents: Dawe - 46.4% and Sipu - 19.6%). Herd structure in the valley mainly comprised of sheep, goats, horses and mules. Estimates of average profits per annum from goat (US$ 202.5) and sheep (US$ 310.7) rearing showed the latter being more profitable.

Scope- Data on herding densities ascertained along the grazing pressure points in the valley were used to demarcate areas for assessment of vegetation health which will be crucial in devising a management plan for sustainable utilization of grazing routes and pastures in the valley for the future.

Keywords: Alpine rangeland, herding routes, Darma valley, Kailash Sacred Landscape

Assessment of capacity building and training needs of key stakeholders in biodiversity conservation in Lahaul and Pangi Valley, Himachal Pradesh

-Meghma Ghosh, Bhoopesh Thakur

The Himalayan ecosystem has immense biological, socio-cultural and hydrological values. However, over time it has come under severe threat due to various anthropogenic pressures including illegal wildlife trade. The project "SECURE Himalaya envisages to ensure conservation of locally and globally significant biodiversity, land and forest resources in the high Himalayan ecosystem. The project aims to conserve snow leopard and its habitats and assess the training needs of key government staff members and community stakeholders for long-term biodiversity management.

The study was conducted in Trans–Himalayan region of Lahaul and Pangi valley, Himachal Pradesh.

A preliminary situational analysis was conducted using secondary data. Key stakeholders were mapped and identified based on different criteria and indicators. A total of 20 villages from two districts were surveyed. The information for Training Need Assessment (TNA) was collected from more than 100 respondents including departmental staff and local communities. To meet the training needs eleven research and training institutes were visited. Open ended questionnaire, focal group discussions and key informants were consulted to identify the capacities of the stakeholders related directly or indirectly towards biodiversity conservation.

On the basis of survey conducted, the study recognized various gaps and training needs of capacities among relevant stakeholders. The key training needs included programs to enhance coordination among forest staff and local community, promoting sustainable forest resource utilization, promoting conservation oriented agro-horticultural practices, controlled grazing and tourism practices. Eight key organizations linked directly with SECURE Himalaya indicators were identified. The existing training modules of the organizations were studied to design a training need framework.

The project further aims to formulate the Capacity Development Strategies and Framework based on TNA. This will involve development of modules based on the training needs for different stakeholders, conducting workshops with all stakeholder groups to finalize the Draft of Capacity Development Strategy and Framework of the project.

Keywords: Wildlife conservation, Snow Leopard, Local communities, Eco-tourism.

Project Title	: Assessment of capacities and training needs of key government staff, community members/institutions and other relevant stakeholders for long-term effective biodiversity conservation in SECURE Himalaya project landscapes in selected districts of Himachal.
Principal Investigator(s)	: Salvador Lyngdoh, Co-PI(s): Dr. Sathya Kumar, Dr. G.S Rawat, Dr. V.B Mathur, Dr. Atul K Gupta, Dr. G.S Goraya, Dr. Y.V Bhatnagar
Researcher(s)	: Bhoopesh Thakur, Meghma Ghosh and Bhawna Pandey
Funding Agency	: GEF/ UNDP Secure Himalaya
Project Duration	: 1 March 2019 – 31 May 2020

Identifying and delineating high conservation value areas across different ecosystems in Lahaul and Pangi Valley, Himachal Pradesh

-Nidhi Singh & Shiv Narayan Yadav

Aim: High conservation value Areas (HCVA) is an emerging concept used to identify important areas based on a variety of parameters including biodiversity, landscape context, threatened or endangered ecosystems, ecosystem services etc. The project aims to identify and delineate potential High conservation value areas while conserving snow leopard, its prey species and their habitat. The six criteria for identifying HCVAs are *Species diversity, Landscape level ecosystems, Ecosystems and habitats, Ecosystem services, Community needs and Cultural values*.

Location: The study has been conducted in Trans-Himalayan region of Lahaul & Pangi valley, Himachal Pradesh.

Methodology: The secondary data has been collected from published sources on distribution of snow leopard and other protected species and various ecosystem services present in the concerned landscape. Areas with high potential for MAPs, faunal diversity, ecosystem services and cultural values were delineated. Also, the areas with least anthropogenic disturbance and high potential for conservation were demarcated using spatial and non-spatial data in GIS environment. Few areas were identified in the study area as potential HCVAs. Sign surveys and local consultations were undertaken to further incorporate the ground data into identification of HCVAs.

Results: After final validation, 9 potential areas were identified, in which 7 were falling in HCV1 & HCV3 criteria, 5 areas in HCV2, 6 areas in HCV4 & HCV5 and 4 areas in HCV6. Also a scoring system matrix was developed for further prioritization of areas, mainly based on distribution of Snow leopard, its prey species and medicinal and aromatic plants. The highest score was given to Miar valley area of Lahaul valley, which shares its boundary with Sechu tuan Nalla WLS of Pangi valley.

Conclusion: The high range Himalayan ecosystem in India is of critical importance for the biodiversity it harbors but is under severe threat due to anthropogenic pressure. To address these threats, the project "SECURE Himalaya" seeks to demonstrate a set of best practices, using HCV concept, to ensure biodiversity conservation.

Keywords: Himalayas, Snow leopard, Biodiversity, Conservation, GIS.

Project Title	: Identifying. Assessing, delineating and mapping areas with High Conservation Values (HCVs) and developing management recommendations/plans for them in SECURE Himalaya project landscapes in selected districts of Himachal Pradesh, India.
Principal Investigator(s)	: Sh. Salvador Lyngdoh Co-PI(s) Dr. Sathya Kumar, Dr. V.B Mathur, Dr. G.S Rawat, Dr. Gautam Talukdar, Dr. B.S Adhikari, Dr. G.S Goraya, Dr. Y.V Bhatnagar
Researcher(s)	: Nidhi Singh, Junior Project Biologist (Ecology) & Shiv Narayan Yadav, Junior Project Biologist (GIS)
Funding Agency	: GEF/ UNDP Secure Himalaya
Project Duration	: January 2019 – February 2020

An Experimental approach to assess the impact of climate warming on lichen growth and physiology in IHR

-Chirag Girdhar

Aim: A Experimental approach to assess the impact of climate warming on lichen growth and physiology in IHR.

Study area: Bhagirathi basin, Uttarakhand.

Methods: We used 15 Open Top Chambers (OTCs) with climatic data loggers in the subalpine and alpine region of Gangotri National Park. Two crustose lichen species *Rhizocarpon geographicum* and *Xanthoria elegans* were identified as focal species for Lichenometry studies and thalli were marked for the future observations. Physiological studies viz., chlorophyll content and chlorophyll degradarion inside the OTC were studied in case of *Cladonia pyxidata* (Soil lichen). With the help of herbarium samples, we investigated the changes in the atmospheric Carbon dioxide by analyzing δ 13C as a representative of global CO_2 increase and also the accumulation of heavy metals over the time using IRMS and ICP-MS respectively.

Results: The pigment analysis of *Cladonia pyxidata* inside the OTC and from control plot showed a considerable decrease in Chl a and b. Inside OTC there was increased chlorophyll degradation and total carotenoids of *Cladonia pyxidata*. We found that δ 13C concentration and the metal concentration in the recent samples is much higher as compared to 40 to 50 years old herbarium samples.

Conclusion: There was no visible impact on the growth of lichens due to experimental warming (2 years) as lichen are extremely slow growing. However in case of *Cladonia pyxidata* there was a decrease in chlorophyll a and b content inside OTC, suggesting decreased photosynthetic activity and growth.

Keywords: Bhagirathi basin; open top chambers; indicators; lichens; Western Himalaya

Project Title	: National Mission on Himalayan Studies: Fellowship programme
Principal Investigator(s)	: Dr. G.S Rawat and Dr. S. Sathyakumar
Researcher(s)	: Chirag Girdhar (JRF)
Funding Agency	: MoEFCC - NMHS
Project Duration	: November 2017 to June 2019

Orchid conservation initiative through community participation in Gori Valley, Kailash Sacred Landscape, India

-Soni Bisht

Objectives: To initiate community based orchid conservation programme for Gori Valley in Indian part of KSL

Project area: Lower Gori valley, Pithoragarh district in the state of Uttarakhand

Methods:

- Rapid survey of orchids covering various habitats following systematic surveys along trails/ transect walks
- Identification of orchid rich localities and awareness generation programme for school children and local community
- Formation of women's self-help group and Orchid Conservation Society/ Biodiversity Management Committee
- Restoration/rehabilitation of orchids and linking with livelihood

Results:

- Baseline data on orchid species diversity/abundance across various habitats
- Selection of forest patch near Lumti as 'Orchid Conservation Area (OCA)' for in-situ conservation

Conclusion: Orchid conservation initiative through community participation in Gori valley has been well established. This will be further strengthened when linked with eco-tourism based livelihood activities and other programmes of State Government especially of SBB and Forest Department

Keywords: Orchid, conservation, Uttarakhand

Project Title	: Mainstreaming Landscape Approach to Biodiversity Conservation, Improved Livelihoods and Ecosystem Health in Kailash Sacred Landscape part of India
Principal Investigator(s)	: Dr. G. S. Rawat, Dr. B.S. Adhikari
Researcher(s)	: Soni Bisht
Funding Agency	: MoEFCC - NMHS
Project Duration	: July 2018 - 2021

Movement and ranging patterns of Rhesus macaques in Chandrabani, Dehradun

-Sayli Suresh Sawant

Aim and introduction: Foraging primates have a well-defined home range which is extensively used for resting, foraging and sleeping sites. Home ranges of primates are influenced by the availability of resources in an area. Human-dominated landscapes such as Chandrabani, Dehradun offer high amount of food resources in the form of garbage dumps. This increases the interaction of macaques with humans and leads to conflict situations. We examined movement and ranging patterns of Rhesus macaques in a human-dominated landscape with a clumped resource distribution.

Study area: A 16 sq.km study area around the Wildlife Institute of India campus, Chandrabani, Dehradun was selected for the study.

Methods: We fitted Lotek Sirtrack-140 GPS collars on four adult females belonging to four different troops and monitored them for 9 – 12 months. Garbage dump locations were mapped along with land use land cover data in the study area. We calculated Minimum Convex Polygon (MCP) and Kernel Density estimates to understand ranging and space use patterns in Rhesus macaques.

Results: The 90% Kernel Density estimates (utility distribution contours) for the same adult females were $0.078km^2$, $0.03km^2$, $0.07km^2$ and $0.026km^2$ respectively. The number of garbage dumps in home range of each troop was 22 (troop A), 7 (troop B), 23 (troop C) and 6 (troop D). The utility distribution contours showed patterns of high usage of selected garbage dumps and low use of forest cover by Rhesus macaques. These results show that human subsidies in the form of garbage dumps may influence the ranging patterns of these animals leading to conflict situations in human dominated landscapes. Thus, understanding movement and ranging patterns of species is important for the management and conservation of the species in the long run.

Keywords: Home range, conflict, human-dominated landscape, space use.

Human-carnivore conflict in Chamba district, Himachal Pradesh: Understanding peoples' perception and reality

-Nitin Bhushan

Aim: Chamba district of Himachal Pradesh falls under pir-panjal mountain range in the north-western part of the Indian Himalayan region. In this region human-carnivore conflict seems increased since last decade especially livestock depredation and human attacks. Thus we aim to assess the extent of human-carnivore conflict and perception of local communities towards large carnivores in Chamba district of Himachal Pradesh.

Location: The study was conducted in Bharmour Forest Division of Chamba district, Himachal Pradesh.

Methods: We used semi-structured questionnaire surveys (N=311 households and N=36 migratory grazers) to assess livestock loss due to large carnivores and also peoples' perception towards large carnivores. We also collated data on human-wildlife conflicts from the *ex gratia* / compensation records of the three Forest Divisions viz., Bharmour, Chamba and Dalhousie in Chamba district, Himachal Pradesh.

Results: Himalayan brown bear, Asiatic black bear and Common leopard were the large carnivores in conflicts in Chamba. On an average, livestock depredation by Himalayan brown bear was 1.86 (SE 0.42) / migratory livestock herder/year and there was no correlation between herd size and number of depredated animals. The average size of a herd was 579.36 (SE 86.36) individuals. Our results also revealed that livestock mortality due to natural calamities or diseases was 8 times more than the livestock loss due to depredation by brown bear in Bharmour Division. Local communities showed negative attitude towards brown bear (84%), black bear (84%), common leopard (93%) and Tibetan wolf (100%). Local communities of Chamba and Dalhousie Divisions reported that 42% of livestock loss due to depredation by leopard during winters. Of the total large carnivore attacks on humans (N=40), black bear accounted for 75% cases. Most of large carnivore attacks on humans were during monsoon (78%) and within 500m of the victim's household's proximity (75%).

Conclusion: Livestock loss due to natural calamities was eight times more than livestock-loss due to depredation by brown bear. Local communities have negative perception towards all large carnivores.

Key words: Large carnivore, Human attacks, livestock depredation, Peoples' perception

Co-occurrence of human, leopard and perceived risk in a shared landscape of North-East India

- Suraj Kumar Dash

Aim: Co-occurrence of common leopard (*Panthera pardus*) with humans in most parts of India is well known. The aim of the study was to understand people's perception towards Human-Leopard Conflict (HLC) in a human-dominated landscape.

Location: The study was conducted in the Dooars region of North Bengal (Darjeeling, Jalpaiguri and Alipurduar districts).

Methods: We conducted semi-structured questionnaire surveys (N=770) to assess people's perception towards HLC and estimated abundance of leopard and prey in 158 km^2 area of Mahananda Wildlife Sanctuary (MWLS) by deploying 35 camera traps in a systematic 5 km^2 grid based design. We investigated the role of socio-economic variables and economic losses due to wildlife damage on perception towards leopard by using ordinal logistic regression using package MASS in program R 3.4.0. Leopard density was estimated by using SECR framework and the relative abundance of prey were estimated based on photo capture rates (#/100 trap nights).

Results: Bhutia community (Hill tribe) had negative perception towards leopards whereas Santhal, Oraon and Munda (Central Indian tribes) had positive perception towards leopard. Length of residency was a significant factor in determining conflict. An average of 2 goats (SE 1.7), 2 cows (SE 1.9), 1 dog (SE 0.7) and 1 horse (SE 0.6) were killed by leopard per household between 2015 and 2018. Livestock holding and economic loss due to depredation by leopard were also significant predictors of perception. Leopard density was estimated to be 13.33/100 km^2 (SE 0.03). Relative abundance (photo capture rate #/100 trap nights) of Indian Peafowl was 26.51 followed by Cattle (23.66), Rhesus Macaque (22.0) and Gaur (19.89).

Conclusion: Leopard abundance in MWLS was high despite low wild prey population and suggests potential for increase in human-leopard conflict. Extent of damage and length of residency were significant social drivers of human-leopard co-existence.

Keyword: Carnivore, North Bengal, conflict, perception, tribe

Project Title	:	Human-Wildlife Conflict Resolution Mechanism in the Indian Himalayan Region: Risk assessment, prediction and management through research and community engagement
Principal Investigator(s)	:	Dr. G.S. Rawat and Dr. S. Sathyakumar
Researcher(s)	:	Suraj Kumar Dash, Junior Project Fellow
Funding Agency	:	MoEFCC - NMHS
Project Duration	:	2016-2020

Pragmatic approach to vulnerability assessment of local community in Trans-Himalaya

-Dharani M, Sipu Kumar and Kalzang Targe

Aim: Indian Trans-Himalaya region is highly vulnerable in terms of natural disasters, geographical location, topography and unique economic-cultural characteristics of the region. The study aims to evaluate the aggregated response of communities by assessing their vulnerability towards resource pattern, livelihood security, herding practices and ethno-medicinal practices in the Trans-Himalaya.

Location: Spiti valley in Himachal Pradesh.

Methods: Spiti valley was divided in to four zones, viz Upper, Middle, Lower and Pin valley zones. In each zone, 30% households were interviewed with semi-structured questionnaire to get the socio-economic status of the communities. Amchis were interviewed for the use of ethno-medicinal plants in the valley. Based on watershed approach, the vegetation data was collected through quadrat method (Misra 1968) based on land form units. Following Hann *et al.* (2009), Livelihood Vulnerability Index (LVI) of communities was calculated for each zone in the Spiti valley.

Results: A total of 69 species (9 in IUCN Red list) were recorded, of which 47 species (27 by Amchis) were used for medicinal purposes. Based on interviews, Gangnam and Darbak (20 and 15 species, respectively with 8 species in common) were identified as the most accessed valleys by Amchis. Twenty seven health aliments were claimed to be cured by using various plant parts (38% flowers, 26% leaves, 14% each roots and stem and 8% seeds). The plant density was high in Khamedngar and Parahio watersheds (20.6 and 20.1 individual m^{-2}) and low in Tsoham and Kinlung watershed (each 17.4 individual m^{-2}). The vulnerability of the zones was in the order: upper zone (LVI: 0.42) > middle zone (LVI: 0.40) > Pin valley zone > (LVI: 0.39) lower zone (LVI: 0.37).

Conclusion: The villages in the upper zone were found to be more vulnerable in terms of livelihood. Most Accessed area by Amchis needs the conservation practices with respect to medicinal plants. Livelihood-vulnerability assessment provides a better mitigation plan for the local community and related flora and fauna. Thus future policies should focus on zone specific requirement for diversification of livelihoods at community level.

Keywords: Trans-Himalaya, livelihood, vulnerability, community

Assessment of selected important Medicinal and Aromatic Plants in Lahaul and Pangi, Himachal Pradesh, India

-Rupali Sharma, Monika Sharma, Manisha Mathela and Himanshu Bargali

Aim: The Himalayan region harbours remarkable plant diversity and has traditionally been an important source of medicinal and aromatic plants (MAPs). The Indian Himalayan region (IHR) accounts for about 50% of the total flowering plants of the country, of which nearly 30% are endemic and *ca.* 1,748 species are medicinal. In IHR, MAPs are usually harvested by the local communities to not only address health concerns, but also as a key source of their livelihood. Unfortunately, trade of MAPs happens largely in an unorganized manner resulting in under-realization of the economic value at the grassroots, while delivering higher returns for intermediaries as one move upstream in the value chain. Most of the MAPs are being collected from the wild thus; their conservation is a key to the survival of the species. Therefore the present study focused on the conservation and trade patterns of selected MAPs.

Location: The study was conducted on Lahaul-Pangi Conservation Landscape that lies between the Dhauladhar-Pir Panjal and Zanskar ranges in Himachal Pradesh in the upper catchment of Chandrabhaga (Chenab) forming a transition zone between the Greater and Trans-Himalaya.

Methods: Based on high quantum of collection or usage (five species) and high threat perception (five species), 10 MAPs namely *Aconitum heterophyllum, Picrorhiza kurrooa, Dactylorhiza hatagirea, Podophyllum hexandrum, Bunium persicum, Rheum australe, Rheum webbianum, Rheum spiciforme, Polygonatum verticillatum* and *Fritilaria roylei* were selected for current study Of the 10 species, 04, 03 and 03 species are Critically Endangered, Endangered and Vulnerable respectively, as per IUCN conservation status. Semi-structured questionnaire with open and closed ended questions, in-depth interviews and focus group discussions were conducted to collect information on selected MAPs.

Results: The study revealed major conservation issues such as over harvesting, destructive harvesting, illegal trade and hidden markets of the selected MAPs with respect to their usage, market and price trends have also been discussed.

Keywords: Biodiversity, Conservation, Himalaya, Threatened species

Current status on diversity and distribution of Odonates (Insecta:Odonata) in the Indian Himalayan region: An overview

-Shuvendu Das

Aim: This study aimed to find out the research gap in terms of total area covered, species diversity, taxonomic and phylo-geographic/biogeographic shortfall in Indian Himalayan region (IHR~60,000 km2) and Odonata assemblages shaped by influence of altitude, vegetation types, environmental parameters, aquatic composition and anthropogenic factors.

Location: Study area consists of Bhagirathi River Basin (IHR~60,000 km^2), Uttarakhand from Indus River System under biogeographic province 2B and Teesta River Basin (BRB~7,000 km2), Sikkim from Ganga-Brahmaputra River system under biogeographic province 1C and 2C.

Methods: Compilation and categorization of all the published research articles based on different types of study in Odonates; e.g. taxonomy, biogeography. Stratified random sampling was carried out in at least one river basin from each Himalayan river system within a range of 500m-4000m. MaxEnt software was used to predict distribution of selected Odonata species in the study area via Analytical Hierarchy Process (AHP). Genetic study involves the sequencing of Cytochrome c oxidase I (COX1) gene of mitochondrial DNA sampled; followed by a comparison with other sequences previously deposited in the database. Species were identified by matching the obtained sequence with sequences previously deposited in the BarCode of Life Data system (BOLD).

Results: Detailed assessment led to listing of 142 research articles from Indian Himalayan region and first scientific documentation on Odonates of Himalaya was published in 1898. But till date, 94% of these studies were based on diversity and classical taxonomic approaches. There is a prominent lack in ecological aspect, behavioral study, phylogenetic study and conservation approaches for mitigating climate change. Our study comprises of 87 species belonging to 45 genera and 12 families in BRB and 32 species belonging to 17 genera and 11 families from TRB. We identified four habitat specific indicator species for BRB: *Tramea viginia* (p<0.013), *Ischnura forcipata* (p<0.004), *Libellula quadrimaculata* (p<0.012), *Trithemis festiva* (p<0.025). First ever generation of DNA sequences were obtained from 74 samples consist of 42 valid species.

Conclusion: Our present study suggests that the species distribution and diversity is underestimated in IHR. The applicability of Odonates as surrogate to monitor climatic or human-caused changes in habitats will be studied.

Keywords: Linnaean shortfall, systematic sampling, BarCode of Life Data system (BOLD).

Assessment of key mammal species in four protected areas of Himachal Pradesh, India

- Ankita Bhattacharya

Accurate assessment of number and species composition in a biological community is imperative to understand trends of species over time. Moreover, abundance, spatial and temporal distribution is important for in-depth knowledge of species ecology. Again, promotion of improved biodiversity conservation approaches in mountainous landscapes also involve national level capacity building through participatory interventions. Our study aims to assess the biodiversity status of four PAs in Himachal Pradesh through participatory interventions.

Our study area included four Wildlife Sanctuaries (WLS) in Himachal Pradesh – Lippa-Asrang, Daranghati, Rakchham-Chitkul and Rupi-Bhaba in Kinnaur district adjoining Uttarkhand and Tibet.

We deployed a total of 88 camera traps in the 4 PAs on a rotational basis for a period of 2 years. Camera trapping was done for a session of 30 days in Lippa-Asrang, 35 days in the other three WLS. Alongside, sign surveys were conducted in pre-existing trails (3 to 10 kms) enroute to deploying the cameras. The forest staff were trained by us in these various sampling techniques prior to field visit. We generated activity patterns of the photo-captured species. We estimated occupancy of selected species using the single species single season model with site covariates elevation, vegetation type, slope, aspect and terrain ruggedness index.

We recorded ~10 mammal species from each WLS. Himalayan goral and Himalayan black bear had high photo capture rates from all 4 WLS. Species richness reached asymptote with 20 camera traps. Species occurrence was mostly influenced by elevation, slope and terrain ruggedness whereas detection probability was mostly influenced by vegetation type. In Lippa-Asrang, we got the first photographic records of snow leopard and Himalayan brown bear indicating new habitat records for these species.

Intensive camera-trapping through participatory approaches is required for a comprehensive information on these mountainous PAs. Introduction of forest staff to modern sampling techniques leads to effective capacity building. For effective management and long term monitoring goals, baseline information is critical giving insights on presence of rare and threatened fauna.

Keywords: Capacity building, camera trapping, occupancy, activity pattern, threatened species

Project Title	:	Assessment of biodiversity for effective management and evaluation of ecotourism potential of four Protected Areas in Himachal Pradesh, India
Principal Investigator(s)	:	Dr. Bilal Habib, Dr. Bitapi C. Sinha
Researcher(s)	:	Ankita Bhattacharya, Senior Research Fellow
Funding Agency	:	Himachal Pradesh State Forest Department
Project Duration	:	May, 2018 - September, 2019

Conservation prospects of threatened and newly discovered mammals of Bhagirathi Basin, Uttarakhand, India

-Ranjana Pal

Aim: We studied the distribution of mammals and their response to anthropogenic disturbances in a high-altitude Himalayan landscape.

Location: The study was conducted in Bhagirathi Basin, Uttarakhand.

Methods: The basin (500-5000 m) was systematically surveyed (16x16 Km grids) using camera traps from October 2015 to May 2019. We compiled our camera trap efforts (N= 209 sites, 33,057 trap days) from October 2015 to September 2017 to investigate the effects of habitat and human-associated disturbance on threatened species using generalized linear mixed models. We used the repeated sampling (summer: April to September and winter: November to February) data for sites by incorporating site as a random effect variable and habitat features (elevation, ruggedness, slope) and anthropogenic pressures (capture rate of humans, dogs, and livestock) as predictor variables. The temporal overlap between species and anthropogenic pressures was assessed using the Kernel density analysis.

Results: We confirmed the occurrence of 39 non-volant mammals out of which nine are threatened, and four are Near Threatened. We recorded six mammals, which were hitherto undocumented in Uttarakhand, viz., Tibetan argali, Tibetan sand fox, Tibetan woolly hare, Eurasian lynx, Woolly flying squirrel, and Pallas's cat. We found the presence of sambar, common leopard, and Asiatic black bear in a wide variety of habitats amidst anthropogenic pressures. Similarly, Snow leopard was found amidst high human presence and shows a negative response to livestock. Musk deer and Brown bear are found in subalpine habitats with less human and livestock presence. The temporal activity overlap analysis during summer shows the highest overlap between Himalayan brown bear and livestock (Δ=0.81) as well as domestic dogs (Δ=0.64), followed by Asiatic black bear and livestock (Δ=0.64) as well as domestic dogs (Δ=0.52).

Conclusion: Our study highlighted the potential of the Bhagirathi basin as a stronghold for some of the endangered and rare species. Nonetheless, the distribution of endangered species overlapped with humans and associated activities both spatially and temporally, and thus these species remain vulnerable to anthropogenic pressures.

Keywords: Endangered mammals, anthropogenic pressures, Spatio-temporal overlap, generalized linear mixed models

Small carnivore community along elevation gradient in the Great Himalayan National Park, Himachal Pradesh

-Meghna Bandyopadhyay

The rugged features of mountains have restricted resources making it challenging for species survival. Riverine area in this context plays crucial role in providing a heterogeneous gradient of resources and facilitating movement. Spatial and temporal interactions of red fox and leopard cat, yellow throated marten and stone marten, and masked palm civet and common palm civet were assessed along the elevation gradient.

Study was conducted in Tirthan valley of Great Himalayan National Park, Himachal Pradesh

Total 81 camera traps were deployed systematically from 1500m to 4000m along the main river with sampling session of 25 days. To estimate spatial pattern of co-occurrence, weekly detections were analysed using generalized linear mixed models. To detect temporal interactions, photo capture time was analysed focusing on activity pattern and coefficient of overlap (Δ).

In lower elevation, red fox and leopard cat showed negative spatial association (-1.2+0.58, significant at $\alpha=0.1$) but were active during same time zones ($\Delta=0.85$). Whereas in middle (0.40+0.71) and higher elevations (2.22+0.37, significant at $\alpha=0.001$) co-detection occurred but were temporally separated ($\Delta=0.36$). This might be due to limited and restricted resources in higher elevation where red fox and leopard cat tend to co- exist spatially but remain active in different time zones. Yellow throated marten and stone marten showed spatial segregation with elevation, the former was detected from 1500m to 3000m in temperate forests whereas the later was confined to sub-alpine and alpine forests (>3000m). Masked palm civet was only detected in the human habited area outside National Park in lower elevation whereas common palm civet was detected (low) away from human settlement inside forested area.

The community dynamics defines adaptability of species with existing anthropogenic and interspecific competition pressures. Being sensitive species, any small-scale habitat alteration may affect the dynamics to great extent. This study will aid in establishing the species interactions and use species-specific requirement to guide the riverine habitat conservation management.

Keywords: small carnivores, gradient

Project Title	: Small carnivore interactions and its anthropogenic correlates along the elevation gradient in Western lesser Himalaya
Principal Investigator(s)	: Dr. K. Ramesh
Researcher(s)	: Meghna Bandyopadhyay , Junior Research Fellow
Funding Agency	: MoEFCC - NMHS
Project Duration	: 3 years

Ghost hunting: Investigating the movement pattern of *Nanorana vicina* in Himalayan Torrent Stream

-Swati Nawani

Aim: To determine the movement and habitat use of *Nanorana vicina,* an obligate stream frog endemic to Western Himalaya.

Location: Benog Wildlife Sanctuary, Uttarakhand, India

Methods: We selected and classified two perennial streams on the basis of anthropogenic modification. Encounter rate of the species was determined through time constrained nocturnal Visual Encounter Survey. We used 10 VHF radiotransmitters fitted as external harness to study the movement of individual male and female frogs. We recorded daily distance covered by each tagged individual using a meter tape and a handheld GPS. Arc GIS – 10.1 software was used to identify the probable home range. To check the relation between environmental parameters and movement we performed multiple linear regression analysis in R 3.6.

Results: *N. vicina* mostly found in pool section of stream with an encounter rate of 2.17 followed by cascade (1.17), riffle (0.61) and runoff section (0.22). Maximum distance moved by an individual is 100 meter in a day and minimum distance is 0. Average movement was more during monsoon (4.25 m/day) than pre - monsoon (2.99 m/day). In the undisturbed stream the average movement of the frogs are higher (5.33 m/day) than that of the disturbed stream (3.33 m/day). Male average movement is higher (2.93 m/day) than that of female (2.84m/day). Maximum seasonal movement of the species was significantly associated with pool depth and relative ($P = 0.0282$ and $P = 0.0448$ respectively, $R^2 = 0.7216$) and not the air and water temperature.

Conclusion: Pool section of streams are most frequently used habitat for both adults and larval forms of *N. vicina.* The study revealed that *N. vicina* has a high philopatry, narrow habitat uses and obligate adaptations to torrent stream environment. Any changes in the stream morphology might impact this species.

Key Words: Amphibian, movement ecology, habitat use, conservation

Project Title	: Spatial Ecology of the Himalayan Torrent Frog Nanorana vicina in response to habitat dynamics
Principal Investigator(s)	: Abhijit Das
Researcher(s)	: Swati Nawani, Project assistant
Funding Agency	: MoEFCC
Project Duration	: 3 years

Vegetation structure and composition: Long-term ecological monitoring across environmental gradients in Sikkim Himalaya

-Dr. Rishi Kumar

The aim of the project is to establish a series of 1- ha plots across the altitudinal and anthropogenic pressure gradients of Sikkim Himalaya and to establish an institutional mechanism for long-term monitoring of these plots. It has three main objectives and in this presentation I will present on objective 2, which is to establish baseline on vegetation pattern along the altitudinal and anthropogenic pressure gradients.

Teesta basin in Sikkim Himalaya covering an altitudinal gradient of 300 to 5300 m asl.

Using a detailed vegetation map of Teesta Valley and following a broad altitudinal and anthropogenic pressure gradient, a series of 1- ha plots for long-term ecological monitoring (LTEM) were established. In addition random vegetation plots were also placed along trails near these LTEM sites. For baseline data we used 20m x 20m quadrats for tree species, nested quadrats of 5m x 5m for shrubs and 1m x 1m for herbs at each site.

Of the 26 long-term monitoring plots, 13 plots were in Protected Areas, and 11 plots in RFs and two plots in multiple use zones. Eight plots in the transition zone between forest types and between treeline and alpine region were very sensitive to climate change, eight plots were also sensitive to resource extraction by people in form of NTFP, bamboo, firewood etc. Three sites were grazed regularly by cattle or yaks and 6 sites were also affected by tourism or the resulting developmental activities. Even though 50% of the sites were in PA, only 8% of the sites were totally free from human influence. A monitoring mechanism has been developed to collect data on some of the key parameters of vegetation at each site (canopy cover, bamboo density, lopping etc.) and an Institutional Mechanism has also been finalized for local agencies to carry out future monitoring.

Vegetation structure and composition of the PAs and RFs sites indicate a decrease in diversity indices along the anthropogenic pressure gradient. Changes are observed in dominant species, canopy cover, increased weed species or cover with the increasing human influence.

Keywords: Anthropogenic pressure, climate change, Teesta basin

Is climate warming converting alpine soil into net carbon source?

-Pankaj Tiwari

Increase in 31% atmospheric CO_2 since 1970 is linked to anthropogenic activities like deforestation, land use change and fossil fuel combustion. However the most dominant source of atmospheric CO_2 remains to be soil respiration, a natural phenomenon of CO_2 emission from soil resulting mainly from microbial decomposition of soil organic matter and root respiration. Soil respiration or soil CO_2 efflux accounts for around 11 times the CO_2 emission by fossil fuel combustion. Slight increase in soil CO_2 efflux induced by current warming rates may lead to high amount of carbon loss from sensitive alpine soils turning them from net C_{sink} to net C_{source}. This study aims at investigating temporal variations in soil respiration under experimental warming and its governing environmental factors in alpine ecosystem of Indian Himalayan region.

The study was conducted in alpine habitat of Bhojbasa (3800-4000m), Gangotri National Park, Uttarakand.

Experimental warming plots called Open Top Chambers (OTCs) were installed to simulate climate warming process. Total 12 OTCs were set up, OTCs 1-4 in November 2016, 5-8 in May 2018 and 9-12 in October 2018, such that 3 different experimental warming durations were achieved i.e., 33 months, 14 months and 9 months respectively. Hourly air temperature (AT) and soil temperature (ST) were monitored by data loggers and soil water content (SWC) was determined through GS1 probe. Soil CO_2 efflux was measured periodically (May, June & July, 2019) using LICOR 8100 Automated Soil CO_2 Flux System.

OTCs increased AT and ST by 1-2.4°C and 0.1-3.3°C respectively and decreased SWC by 0.01-0.12m³m⁻³. Soil CO_2 efflux increased in both OTCs and control plots in order May<June<July and was more positively correlated with ST as compared to AT. The efflux increased in OTCs with 9 and 14 months warming, with negligible change in OTCs with 33 months warming. In comparison to control, respiration quotient or Q_{10} value was 28.3%, 5.5% and 2.4% higher inside OTCs with 9, 14, 33 months warming respectively suggesting increase in temperature sensitivity of soil respiration under warming conditions.

Keywords: climate warming**,** open top chambers, LICOR-8100

Influence of snowmelt water on structural and functional attributes in alpine meadows

-Rahul Kumar

Aim: The focus of present study is to understand influence of snowmelt water on species composition, diversity, richness, phenology and biomass of different alpine plant communities constitute alpine meadows.

Location: The study was conducted in alpine meadows of Tungnath region between 2900 and 3680 m asl (subalpine to alpine), which is in the upper catchment of Alaknanda river in Chamoli district, Uttarakhand.

Methods: On basis of physiognomic characteristics, 5 communities viz. Mixed herbaceous, *Polygonum*, Mixed *Danthonia, Danthonia* and *Trachydium* community with 3 sites each were identified and further divided into early and late snowmelt sites on basis of snowmelt pattern. The species abundance, richness and biomass was enumerated following Misra (1968) and phenological events as per the BBCH scale following Hess et al. (1997) repeatedly after 20 day interval.

Results: A total of 82 species were recorded of which 88% were perennial forbs and 77% were native to Himalaya. The density was several fold higher in early snowmelt (401 ind. m^{-2}) sites than late snowmelt sites (155 ind. m^{-2}). One-way ANOVA showed significant difference in densities, species richness and biomass between early and late snowmelt sites. The average species richness was higher in early snowmelt sites than late snowmelt, while total species richness, species diversity and biomass were high in late snowmelt than early snowmelt sites. The early phenophase was noticed in all the species in early snowmelt sites than that of the late snowmelt sites especially in initiation of different phenophases. Eight species were observed in flowering immediately after the snowmelt, while 11 species were in bud development phase in May. It was observed that long growth cycle species like *Oxygraphis, Anaphalis, Anemone,* and *Potentilla* have longer lifecycle by minimum of 10-15 days in early snowmelt sites than in late snowmelt sites. Maximum species were in vegetative phase in June and July, while maximum species flowered between June and September. Most of the species were in fruiting and seed maturation phase in August and September after which they entered senescence phase during October. *Oxygraphis, Fragaria* and *Rannunculus* had two distinct periods for budding, flowering, and fruiting phenophases.

Keywords : Phenophase, BBCH scale, snowmelt

Project Title	:	Influence of micro-climatic variables in herbaceous plant communities in treeline ecotone in the Himalaya
Principal Investigator(s)	:	Dr. B.S. Adhikari
Researcher(s)	:	Rahul Kumar, Junior Research Fellow
Funding Agency	:	NMHS-MoEF&CC through CHEA, Nainital
Project Duration	:	April 2016-2020

Escalators to extinction: Decoding climate-induced future trajectories for the Himalayan Snow Trout

-Aashna Sharma

Aim: The effects of climate change exacerbate in Himalaya, where glaciers melt at a pace six-times higher than elsewhere. Snow trout, an iconic cold-water species, is at greater risk, being an endemic restricted to Himalaya. Understanding the future trajectories of this species in response to climate change, is utmost important to conserve the lotic ecosystems of high-altitude Himalaya. The present study aims to envision the current and future bioclimatic niches of Snow trout using consensus multi-model approach, as strong mitigations warrant stronger predictions.

Location: Core Himalaya was delineated as the study area, further split into Indus, Ganga and Brahmaputra basins representing west, centre and east respectively. Field data collections were made in Beas, Bhagirathi and Teesta basins representative of the former three respectively.

Methods: Primary data was collected using cast, drag and kick nets (August 2015- June 2019). Secondary data was obtained from literature review and online biodiversity databases. Obsolete and dubious records were removed by manual filtering. Sampling bias was further quarantined by statistical sub-samplings of occurrence data. The present and future models were built using nine algorithms including machine learning, boosting and bagging approaches. Six Generalised Circulation Models were used based on the recent Intergovernmental Panel for Climate Change (IPCC)/ Coupled Model Intercomparison Project 5 (CMIP5) experiment. A total of 225 models were built (9 niche-based models × 5 cross-validations × 5 pseudo- absences samplings).

Result: Model evaluation resulted in six best models with Random Forest showing the highest predictability (Thresholds: True Skill Statistics=0.88, Receiver Operated Characteristic Curve=0.97). A distinct contraction was predicted on the lagging range edge of the species distribution. There was an overall loss of 21% (4072 km^2) in occupied drainage area. Occurrence-weighted centre of gravity polygons revealed a future shift in south-east direction.

Conclusion: Climate change is forcing the species' movements to higher elevations, leaving lesser habitat available to be occupied. As such, future refugia drainages were identified for climate-adaptive mitigation measures. However, the barrier effect posed by dams/weirs in the Himalayan rivers hampers the prospective movements of this species.

Keywords: Climate change, range shift, ensemble

Mapping the potential effect of climate change on the distribution of Himalayan Pit Viper (*Gloydius himalayanus*)

-Naitik Patel

Introduction: Ectothermic tetrapod vertebrates are popular model organism for predicting the effects of climate change. Although many species have undergone range expansion and range contraction, data on several taxonomic groups are still lacking. Himalayan Pit Viper (*Gloydius himalayanus*) is distributed from 1000-4800m elevation and is endemic to Western Himalaya. Its wide distribution across available elevation zones coupled with its physiological constraints of temperature, humidity and limited vagility makes it an ideal model for climate change studies.

Location: The study area consists of Northern Pakistan, India (Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh), Nepal and Bhutan. The study area was delineated based on ecoregions.

Methods: In this study, we used bioclimatic variables for the Himalayan Ecoregions combined with presence data of *G. himalayanus* to predict their current and future distribution under the available Representative Concentration Pathways (RCP) scenarios namely, RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5 for the near (2050s) and distant (2070s) future of three Global Circular Models (HadGEM2-ES, CCSM4 and MIROC-ESM-CHEM). We used maximum entropy MaxEnt 3.4.1 species distribution modeling to map the current and predicted future distribution of Himalayan Pit Viper in the study area.

Results: Our bioclimatic model showed that the current suitable habitat of *G. himalayanus* encompasses 97,937 km^2 in the study area. Our analyses demonstrated that the suitable habitat will be reduced by 21% (20,542 km^2) across the landscape by 2050, predominantly due to the changes in the precipitation. Such changes in critical climatic variables may significantly affect its distribution.

Conclusion: Future changes in temperature and precipitation may force *G. himalayanus* to move towards higher elevation zones as precipitation of driest quarter is decreasing in the higher elevation. Furthermore, mapping of forest fire and land use pattern in the alpine region is needed to conserve the habitat of this species. As this might be the only snake species in the higher elevations, it may have consequences on the trophic cascades.

Keywords: Himalayan Pit Viper, Distribution, Climate Change, Climate envelope modelling, Himalayas

Dwindling traditional knowledge and livelihood vulnerability of an agro-pastoral community in Western Himalaya

-Dr. Naveen Chandra Joshi

Aim: This study aims to evaluate the impact of climate change on the agro-pastoral practices, which are primary livelihood activity of Barpatiya community in western Indian Himalayan region, which are the least known settlers of Himalaya.

Study Area: The study was conducted in Eastern part of Uttarakhand covering 13 Barpatiya villages in Munsyari Blocks of Pithoragarh district.

Methods: Detailed survey of Barpatiya community to access the current status of their traditional knowledge and agro-pastoral production vis-a-vis changes due to climate change and other factors was done. We used IPCC climate change vulnerability framework (2014) to estimate the livelihood vulnerability indices (LVI) and used the information on the socio-demographic profile, livelihood strategies, social networks, traditional knowledge, health, food security, water security, biomass availability and natural calamities. Information on 42 different indicator values under 9 components were standardized using maximum-minimum standardization and pooled to calculate LVI by using standard indices. A total of 303 individuals (37% population) were interviewed through semi-structured questionnaires and 13 group discussions were also held in a group of 10–15 villagers to get the general views on different socio-economic and climatic variables. The climatic data was extracted from the worldClim climate data source.

Results: Analysis of data reveals that the households located at lower altitudes are more at risk of vulnerability in comparison to settlements at higher altitudes in Himalaya. The agro-pastoral based livelihood was most vulnerable due to natural calamities (0.604) followed by water security (0.598) and social network (0.564). 5 among the 13 Barpatiya villages were found to be highly vulnerable to climate change whereas, 4 were found to be moderately vulnerable.

Conclusion: The traditional knowledge related to agro-pastoral production among the Barpatiyas is declining rapidly. Households at lower latitudes, especially nearby to sub-urban are more vulnerable to climate change. This may be linked to a rapid decline in forest cover, increased soil erosion and changing hydrology. This calls for policy intervention, which will make such households more adaptive and resilient to changing climatic conditions.

Keywords: Barpatiya, climate change, IPCC, adaptive capacity, policy intervention

Comparative assessment of adaptive capacity and vulnerability of Western and Eastern Himalaya

-Prashant Tariyal

Aim: Indian Himalayan region (IHR) is prone to climate change hazards due to its fragile geography, which directly impacting the livelihood and vulnerability of the people depending on the natural resources of the region. In the present study household and village level adaptive capacity and vulnerability was assessed in western and eastern Himalaya in three river basins.

Study Area: Bhagirathi Basin of Uttarakhand and Beas Basin of Himachal Pradesh were selected in Western Himalaya and Teesta Basin of Sikkim was selected in Eastern Himalaya for the sampling.

Methodology: Villages to be surveyed were selected from different clusters formed through twostep algorithm on the basis of different characteristics viz; altitude, geographical area, population remoteness index and proneness to climate shock of the villages. Household level questionnaire survey was done in selected villages using semi structured questionnaire to collect information on the capital assets and the climate hazards faced by a particular household following household economy approach (HEA). 646 households of Bhagirathi Basin, 454 of Beas Basin and 246 of Teesta Basin were surveyed from 30, 27 and 20 villages respectively. Information on different indicator values were standardized using maximum minimum standardization and cumulative score of all the indicators under human, physical, financial and natural capital assets were used to generate household and village resilience score. The indicators values of climate shock were deducted to get the vulnerability of the villages. Villages were classified as resilience and vulnerable on the basis of values of capital assets and resilience score.

Result: Villages of Bhagirathi basin of Western Himalaya was found to be more resilience in compare to the villages sampled in the Beas basin and Teesta basin. More than 41% of the households of Teesta Basin were vulnerable and 49% were moderate where resilience score was just above the average resilience score. Villages of Beas Basin also have around 75 % households that have low or medium adaptive capacity.

Conclusion: Identification of vulnerable and resilience group is important for climate change adaptation and mitigation planning in any region. The present study will help in identifying the groups which needs policy intervention for climate change adaptation.

Keywords: Indian Himalayan region, adaptive capacity, climate shock, vulnerability

Quality of life: An approach to explore nexus between human well-being and ecosystem services in the Bhagirathi river basin

-Tanvi Gaur

Aim: Ecosystem services are benefits obtained from ecosystems that are vital for human well-being at all scales. Links exist in both directions between the flow of ecosystem services and the level of human well-being. We aim to appraise human well-being using Quality of life (QoL) Index approach that provides a description and evaluation of socio-economic condition of the households in an area and explored its link with ecosystem services at landscape-level.

Location: We investigated this aspect in the Western Himalaya, focusing on Bhagirathi basin, a part of Ganges watershed that drains almost 8846.64 sq. km area in the Uttarakhand state. The river Bhagirathi is major source of water to the tributaries of the river Ganges irrigating 23.41 M-ha of the fertile plains of northern India. The river basin provides an economic base for a wide array of services including agriculture, forestry, fisheries, drinking water and experiences huge developmental pressure pertaining to changing land use practices.

Methods: Based on the population census data of India carried once every 10-year, fuelwood use was identified as the key ecosystem service and the other non-income components such as health, access to basic services, assets, education and work opportunities available to individuals were used to assess and map QoL Index.

Results: QoL index (0.18-0.89) provided a description of well-being of the households in the villages (N=1731) encompassing the Bhagirathi basin. A correlation analyses indicated a negative correlation between fuelwood use and QoL index values (R= -0.40, p= <0.05) indicating households relying on fuelwood as primary source of energy for cooking have low quality of life.

Conclusion: The study provides exemplary findings that bridges the gaps in our knowledge of the link between landscape attributes, ecosystem services and human well-being operating in the river basin. The study can further be used to guide public policy towards the goal of enhancing human well-being and sustainable management of natural resources in the long-term.

Keywords: Fuelwood use, landscape-level, population census of India, socio-economic, Western Himalaya

Assessment of human-black bear conflicts in agro-pastoral mountainous landscape of eastern Himalaya

-Abhisek Chettri

Aim. To understand the extent of Human- Asiatic black bear conflict in an agro-pastoral landscape of Eastern Himalaya.

Location. The study was conducted in North Sikkim and North Bengal region of West Bengal respectively.

Methods. The study was carried out in between 2017-2019. We compiled secondary data on human-black bear conflict maintained by West Bengal and Sikkim Forest Departments and investigated black bear livestock depredation (N=127, Sikkim & N=33, West Bengal), crop depredation (N=130, Sikkim& N=87, West Bengal). We used Rare events model in R and ArcGIS to prepare human-bear conflict risk map and identify ecological drivers of human-bear conflict. We also conducted questionnaire surveys from North Sikkim (N=137) and North Bengal (N=770) to understand the perception of local people towards black bear.

Results. During the years 2017-2019, an average of 2 (±0.14) and 3 (±0.28) livestock per year were predated by black bear in North Sikkim and North Bengal respectively. Goats were the most predated livestock (77%) followed by cattle (21%), horses and pigs (2%). Moderate dense forest (+), distance from water (+), nightlight (+), human density (-), livestock holding (+) and distance from PA (+) were significant ecological drivers of predation risk and crop damage. Majority (69%) respondents had negative attitude toward black bear followed by neutral (21%) and positive (9%). Livelihood type (agriculture, government job, tea-estate workers), livestock holding and landholding size were significant predictors of perception towards black bears. People with large land holding and/or in a Govt job had negative attitude towards black bear.

Conclusion. Landscape variables (Moderate dense forest, slope), and distance from water source and anthropogenic variables (human density, nightlight, livestock holding) were significant predictors of human-bear conflicts. However, visual encounters of black bear and /or livestock or crop depredation generates of lots of attention from the media and Government.

Keyword: Livestock depredation, crop depredation, Khangchendzonga, Perception, Attitude

Project Title	:	Human-Wildlife Conflict Resolution Mechanism in the Indian Himalayan Region: Risk assessment, prediction and management through research and community engagement
Principal Investigator(s)	:	Dr. G.S. Rawat and Dr. S. Sathyakumar
Researcher(s)	:	Abhisek Chettri, Junior Project Fellow
Funding Agency	:	MoEFCC - NMHS
Project Duration	:	2016-2020

Relative abundance of major mammalian prey: Implications for human-wildlife conflict management in human dominated landscape of western Himalaya

-Gaurav Sonker

Aim: To assess relative abundance of common leopard and its major prey in a human dominated landscape of the western Himalaya.

Study area: The study was conducted in five different administrative blocks, viz., Khirsu, Pauri, Ekeshwar, Pabau and Pokhra of Pauri Garhwal district of Uttarakhand from November 2017 to July 2019.

Methods: We walked trail transects (N=154, total effort = 311km) to determine abundance of leopard, and its prey. We performed mark-recapture based camera trapping (grid size 5 km^2) and estimated abundance of leopard and prey in an area of 315 km^2 (3,969 trap nights). Abundance of prey was assessed using camera trap based photographic capture rates. To assess leopard occurrence within the human-dominated landscape, we used data of leopard presence (recorded through trails and camera traps) in binary framework through (GLM) models along with other climatic, landscape and anthropogenic variables at 1 km^2 scale.

Results: Based on Spatially Explicit Capture Recapture framework, we estimated leopard density as 12.73 (±4.3 SE) individuals /100km^2. Relative abundance (#/100 trap nights) of Indian hare was the highest (16.91), followed by wild pig (2.73), barking deer (1.41) and sambar (0.10). The encounter rate of leopard signs was 2.0(±0.33 SE) signs/km, followed by galliformes (0.51 ±0.15), rhesus macaque (0.32 ±0.10), barking deer (0.30 ±0.18), wild pig (0.24 ±0.06), langur (0.19 ±0.06), sambar (0.07 ±0.16) and goral (0.016 ±0.001). Among the domestic prey, encounter rate of cattle was found to be highest (3.35 ±0.31)/km, followed by goat and sheep (1.65 ± 0.23). Based on GLM regression models, the lowest AIC value model ($\Psi_{Habitat\ use}$= β_1DEM + β_2Slope + β_3Aspect + β_4Distance from PA) for Habitat use by leopard (AIC 135.24) determined by DEM (+), slope (+), aspect (-) and distance from protected area (-).

Conclusion: The predator density was high, i.e., approx 13 leopards/100km^2 with less abundance of natural prey and high abundance of livestock, which may intensify human-leopard conflict in this landscape.

Keywords: Wild prey, domestic prey, encounter rate and SECR.

Perceived risk from large predator and efficacy of non-lethal deterrent as a potential tool to resolve human carnivore conflicts

-Pooja Chaudhary

Aim: Because of wide ranging patterns, survival of large carnivores often depends on cultural tolerance and perceived risk, benefits of local communities. Thus, we conducted the present study to understand social drivers of conflicts and evaluated efficacy of non-lethal deterrent as a tool to mitigate human-carnivore conflicts within a human-dominated mountain landscape of western Himalaya.

Location: The study was conducted in four blocks viz., Khirsu, Ekeshwar, Pabou and Pauri of Pauri Garhwal district, Uttarakhand. This is predominantly a mountainous district encompassing the lesser and middle Himalaya (295 - 3100 m).

Method: We assessed perception of local communities towards human-carnivore conflicts and quantified the extent of livestock depredation by using semi-structured questionnaire during January 2017 - March 2019. To test the efficacy of deterrents in reducing human-carnivore conflicts, we used solar-foxlight as a visual non-lethal deterrent around households and livestock enclosures. We tested the efficacy of these lights at two different spatial scales (50 m and 500 m) and collected data on livestock depredation by common leopard from experimental sites (n=16) and control sites (n=16) between June 2018-June 2019.

Result: Multinomial regression suggests age, education and livelihood type (livestock farming) as significant social drivers of perception towards leopard. Leopards killed an average of 1 livestock per household annually between 2015 and 2018. There was significant difference in livestock depredation between experimental and control sites with 81% more livestock depredation by leopard nearby control sites (without deterrents). Certain landscape and anthropogenic variables affected livestock depredation such as presence of vegetation cover (moderate dense forest) and domestic dog near households. At a fine scale of 50 m, presence of domestic dog (0.015) was the significant factor affecting livestock depredation (P<0.015) whereas at 500 m presence of moderate dense forest (0.00045) was the significant predictor of depredation by leopard (P<0.0004).

Conclusion: Education status, older age and livelihood type were the major social drivers of human-leopard conflicts and the sites without foxlights experienced 81% more livestock depredation by leopard. Our study demonstrates that non-lethal tools has the potential to provide effective solution for mitigating human-carnivore conflicts.

Keywords: Common leopard, perception, foxlight, depredation, community.