Preliminary assessment and conservation of insect pollinators through community participation in the Lahaul and Spiti district of Himachal Pradesh, India

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Pollination contributes an enormous economic value to the reproduction of the flowering plants, in the wild and the managed ecosystems of the world. Biotic pollination, particularly from insects is vital to sexual reproduction and genetic diversity of cultivated and wild plants. Disorder in the pollination system and the decline of pollinators are identified as potential consequences of anthropogenic land use change. Land clearance, habitat fragmentation, changing agricultural practices, herbicides, pesticides and the introduction of non-native exotic plants and pollinator species have resulted in pollination crises. Considering the above facts, this study was conducted in the Indian Trans-Himalayan Region (THR). Major Insect pollinators taxa have been selected to identify the important contributors in the pollination services. Conservation awareness programmes, Hands on training and knowledge publicity materials were used for sensitization of different stakeholders.

Keywords: Climate change, community participation, ecosystem services, insect pollinators, land use.

POLLINATION is one of the pivotal services provided by insects in natural and managed ecosystems. But their population is facing several threats due to land-use changes and unsustainable land-use practices. Land-use changes are said to be one of the most important global issues alongside climate change that will lead to species loss. Loss of species from the community can have cascading effects on the ecosystem. Loss of pollinators will hamper the pollination of unique floral of the Trans Himalayan Region (THR) of India resulting in the loss or reduction of the range of its rare and endemic fauna. The pollinators of THR especially have short life cycles and long hibernation seasons. Global climate changes and land use shift can cause a mismatch between pollinator emergence and floral appearances. Thus, the huge loss of plant reproduction and seed formation affect humans and wildlife equally. Loss of pollinators will further reduce the reproduction and genetic diversity of the rare Trans Himalayan flowering vegetation, which will in turn affect wildlife and people of the region. The THR has a short agricultural growing season that spans from 3 to 5 months. The loss of mutualists such as pollinators due to floral–faunal mismatch in emergence and habitat loss will adversely affect food production in an already food-scarce region[1–3]. This could lead to increased dependency on imports and deterioration of socio-economic, cultural and traditional structures of the THR which are closely knit with its well-being and conservation.

The THR is also witnessing shift in land-use practices and increasing anthropogenic pressure. Insect pollinators are extremely sensitive to such changes and loss of natural habitats can affect the nesting, foraging and breeding sites of pollinators[4–6]. Thus it is important to assess the impact of climate change and degree of decline in insect pollinator populations at the landscape level. Inclusion and sensitization of all stakeholders (landholders and volunteers, agricultural industry, government and NGOs) is required for effective landscape-level interventions. Considering all these facts, the present study was initiated in Lahaul and Spiti district of Himachal Pradesh. It has been observed that traditional mixed farming is transforming into high-value cash crops in the study area. Homogenization of crops is also increasing due to monoculture practices. Inappropriate use of insecticides and agriculture intensification are also potential threats to the diversity of pollinators in the study area.

Overgrazing of natural habitats can affect the nesting, foraging and breeding sites of the pollinators. This will cause the decline in the pollinator populations, which in turn will result in reduction of plant populations unique to the region. Loss of rare endangered flora will further affect the unique wild herbivores of the region dependent on vegetation. Loss in wilderness and the species associated with it will further affect the productivity of the cultivated plants, which will have a direct impact on the food, nutrition and socio-economic patterns of the THR.

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The study area has been stratified on the basis of elevation, habitat and vegetation types and managed lands to explore the diversity of pollinators along each gradient. Each site has been selected randomly in the various altitudinal categories so that the all types of habitats could be sampled more rigorously. Several sampling sites have been selected at each stratum so that comprehensive representation of the diversity at different habitats and fragments largely reflecting the local communities could be accounted. Topographic information such as altitude and location was recorded using GPS.

Reconnaissance survey was initiated in the THR of Lahaul and Spiti district. Fourteen sampling sites falling under different villages (Guling, Kungri, Kaza, Kee, Kibber, Sagnam, Telling, Mudh, Tabo) in Spiti valley (Figure 1 and Table 1), and 35 sampling sites in four valleys (Pattan Valley, Miyar Valley, Toth Valley and Teenath Valley) in Lahaul region (Figure 1 and Table 1) were selected for insect sampling and capacity-building programmes on pollinators conservation and awareness programmes for local communities. The THR is a high-altitude, dry area with rugged mountainous landscape and open plains north of the Himalaya. The local communities follow a traditional agro-pastoralist and nomadic, semi-nomadic and settled village culture. Livestock grazing and associated use of pasture lands has an important ecological history and is a common practice of land use.

Table 1. List of sampling sites in the Lahaul and Spiti district, Himachal Pradesh, India

Location	Latitude	Longitude
Mudh	31°57′29.58	078°01′56.28
Teling	31°59′12.22	078°04′30.99
Sagnam	32°01′28.58	078°03′24.90
Jaldu	32°01′58.69	078°04′19.65
Tangati	32°02′30.92	078°06′21.89
Guling	32°02′36.76	078°05′24.20
Kungari	32°02′42.22	078°04′46.38
Pin Valley National Park	32°02′33.14	077°58′31.26
Poh	32°03′00.51	078°19′09.35
Tabo	32°05′35.17	078°23′09.55
Kaza	32°13′22.68	078°04′19.52
Komic	32°13′53.71	078°06′31.03
Hikkim	32°14′48.63	078°05′32.97
Kee	32°17′32.50	078°00′47.76
Pattan valley-1	32°38′23.11	076°52′25.69
Pattan valley-2	32°36′32.41	076°52′48.73
Pattan valley-3	32°43′43.31	076°39′31.23
Pattan valley-4	32°26′01.92	077°11′33.95
Pattan valley-5	32°36′56.84	077°52′46.90
Miyar valley-1	32°44′44.79	076°41′50.85
Miyar valley-2	32°46′05.46	076°42′12.59
Miyar valley-3	32°47′32.28	076°43′09.84
Miyar valley-4	32°49′28.31	076°44′27.33
Miyar valley-5	32°51′16.57	076°47′22.45
Miyar valley-6	32°51′43.57	076°48′55.32
Miyar valley-7	32°52′12.14	076°51′01.90
Miyar valley-8	32°40′50.46	076°41′26.87
Toth valley	32°33′46.12	077°03′50.89
Toth valley	32°35′26.12	077°07′37.85
Toth valley	32°37′33.99	077°09′46.05
Toth valley	32°40′18.17	077°11′52.72
Toth valley	32°41′44.22	077°13′21.33
Toth valley	32°44′44.61	077°15′10.86
Toth valley	32°47′23.14	077°17′18.31
Toth valley	32°47′28.51	077°19′38.47
Toth valley	32°47′08.13	077°21′17.92
Toth valley	32°45′48.47	077°23′57.20
Toth valley	32°45′22.09	077°24′47.14
Toth valley	32°47′13.00	077°20′54.80
Toth valley	32°47′31.36	077°17′47.06
Toth valley	32°46′32.72	077°18′44.18
Toth valley	32°30′59.55	077°58′50.49
Toth valley	32°30′33.37	077°00′24.84
Toth valley	32°30′15.66	077°03′00.17
Toth valley	32°29′05.85	077°06′36.39
Teenath valley	32°28′34.40	077°07′37.70
Teenath valley	32°25′00.71	077°13′58.93
Teenath valley	32°36′59.96	077°53′44.96
Teenath valley	32°36′44.79	077°54′54.60

Table 2. List of Hymenoptera from Lahaul and Spiti

Family	Species
Andrenidae	*Andrina flavipes*
Apidae	Anthophora sp. 1
	Amegilla sp. 1
	Anthophora sp. 2
	Anthophora sp. 3
	Anthophora sp. 4
	Anthophora confusa
	Apis dorsata
	Bombus agrorum
	Bombus asiaticus
	Bombus haemorrhoidalis
	Bombus rufofasciatus
	Bombus subtypicus
	Bombus tunicatus
	Ceratina hieroglyphica
	Tetralonia hungarica
	Apis melifera
	Eucera parvicornis
	Eucera clypeta
	Xylocopa fenestrata
	Xylocopa sp. 1
Chrysididae	*Chrysis angustata*
	Chrysis sp. 1.
Scoliidae	*Elis fimbreata*
Vespidae	*Eumenes bengalense*
Halictidae	*Halictus kessaleri*
	Sphecodes rubicundus
	Halictus pallens
	Halictus sp. 1
	Halictidae sp. 1
	Halictidae sp. 2
	Jetraponica trincta
	Halictus scaliosa
	Halictus mulachurus
Megachilidae	*Megachile maritima*
	Megachile sp. 1
	Megachile sp. 2
	Megachile sp. 3
	Megachile sp. 4

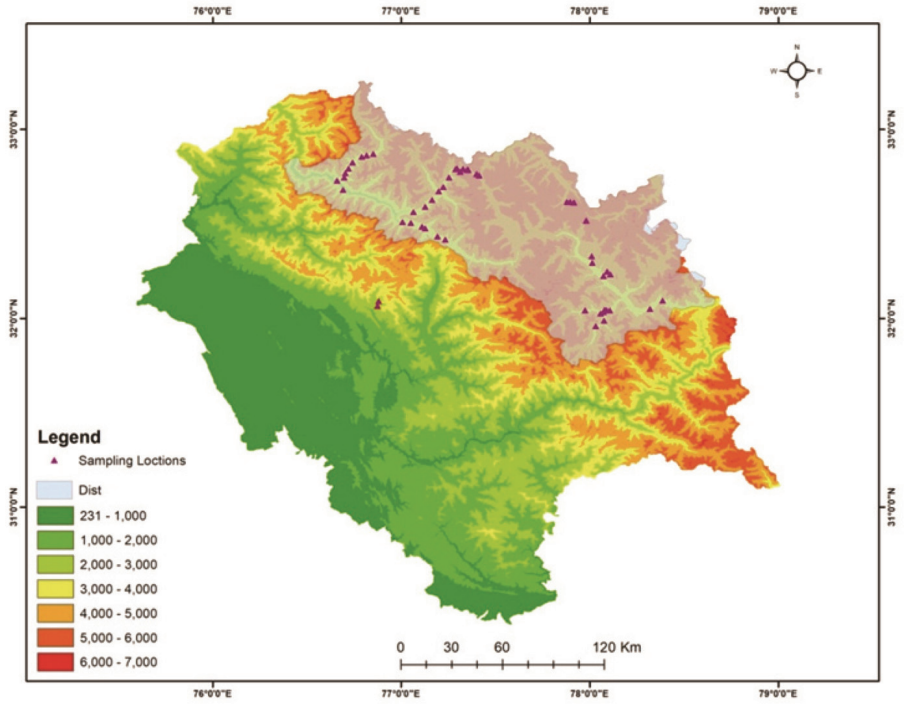

Figure 1. Study sites in Himachal Pradesh, India.

Table 3. List of Lepidoptera from Lahaul and Spiti

Family	Species	Common name
Lycaenidae	*Albulina chrysopis*	Golden green underwing
	Lycaena phlaeas	Common copper
	Heliphorus bakeri	Western blue sapphire
	Spindasis nipalicus	Sliver grey silverline
	Albulina omphisa	Dusky green underwing
Nymphalidae	*Issoria isaaea*	Queen of Spain butterfly
	Aulocera swaha	Common satyr
	Vanessa indica	Indian red admiral
	Neptis hylas	Common sailor
	Danus chrysippus	Plain tiger
	Junonia lemonias	Lemon pansy
	Junonia iphita	Chocolate pansy
Pieridae	*Pontia daplidice*	Bath white
	Pieris canidia	Indian cabbage white
	Pieris canidia	Common Indian cabbage
	Colias erate	Pale clouded yellow
	Eurema hecabe	Common grass yellow
	Pareronia hippia	Common wanderer
	Delias belladonna	Hill Jezebel
Hesperiidae	*Choaspes benjaminii*	Indian awlking
	Celaenorrhinus pyrrha	Double spotted flat
	Pelopides sinensis	Chinese swift

The study area consists of small fragmented villages in the hilly region at various altitudes. The major occupation in this region is farming and is entirely dependent on fruit and vegetable farming as a cash crop. Crop cultivation is also done at the secondary level; the orchards consist of apple trees, plum, peach, pear, apricot, etc. and vegetables like cauliflower, cabbage, pea, potato, etc.

A total of 61 species of insect pollinators have been recorded from the agro-ecosystem and natural forest consisting of order Hymenoptera (39 species) (Table 2) and Lepidoptera (22 species) (Table 3). Solitary bees were reported to be the most diverse group of Hymenoptera. Citizen science approach and capacity building were the major tools for enhancing awareness on insect pollinators and their conservation. Hands-on trainings have been organized for youth for a primary understanding of insect pollinators.

The prevalence of monocultures, cash-crop farming and the inappropriate use of insecticides has been observed in the study. Capacity building and hands on training programmes were organized for all stakeholders (frontline staff of Forest Department/village youth/organizations of local communities). A total of 279 beneficiaries participated in the exercise. Group discussions and meetings were conducted for local communities. Lectures on conservation of insect pollinators were delivered to youth and school children. A total of 362 children participated in the exercise. A number of initiatives have been developed innovative approaches and curriculum material, which can be used as a basis for scaling-up the capacity building to manage pollination services. Capacity building of local communities, youth, school children and baseline agencies has been achieved through workshops, conservation awareness programme and hands-on trainings and workshops have been organized for the conservation of insect pollinators in selected villages of the region. To begin with, village-level biodiversity groups

Figure 2. Pamphlets on the conservation of insect pollinators.

were organized in the study villages to sensitize regarding the mitigation of land-use changes, climate change and mitigation measures adopted by the communities. Exercise developed linkages between communities and natural resources of poor rural households. Publicity material on the conservation of insect pollinators was prepared as bilingual pamphlets and distributed (Figure 2).

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[7–10]. Therefore, maintenance of pollinators and pollination services in agricultural areas where such services are required is of utmost importance. In this region, insecticides are commonly used as sprays and seed treatments. Organic farming which traditionally uses less agro-chemicals than conventional farming has been shown to be beneficial for pollinators, insect pollinated plants and pollination services to both crops and wild species. Increasing cash-crop farming based on monocultures in this region has contributed to reduction in the diversity of plants that provide food for pollinators, which ultimately leads to a decline in insect pollinators diversity. A scientific database has been generated from this study which will be helpful to assess the impact of shifting land-use pattern. Also, changing land-use patterns are closely associated with the socio-economic conditions, which is a major concern for conservationist and policy makers. Species-level studies could resolve and provide a strong foundation for such policy-making decisions.

In the past, mountain farmers grew a variety of crops which bloomed at different times of the year and provided food for a number of natural insect pollinators. So the diversification of agriculture could be an excellent resolution. Economic incentives to farmers could be effective towards pollinators conservation. This study provides a scientific database for effective land-use management, and insights for future conservation and management planning which will help priority areas for habitat improvement or restrict areas from further deterioration. Heterogeneity of habitats within farmlands can be beneficial for biodiversity, and more heterogeneous

landscapes provide benefits for both butterflies and bumble bees. This can be achieved by the maintenance of field margins and poly culture. Less intensively managed farming systems, especially those with less pesticide use, are generally more beneficial for pollinators and pollination. Workshops and training programmes are necessary for the empowerment of local communities, youth and base line agencies. This tool also helps in planning process for adopting specific strategies and prioritizing insect pollinator conservation efforts.

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