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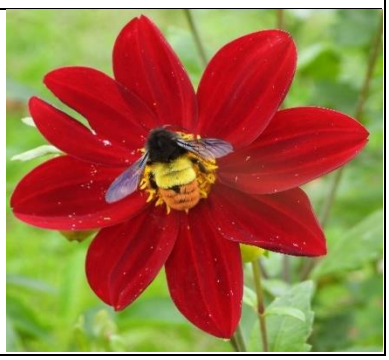
Policy brief

Diversity and Importance of Bumblebees in Indian Himalayan Region

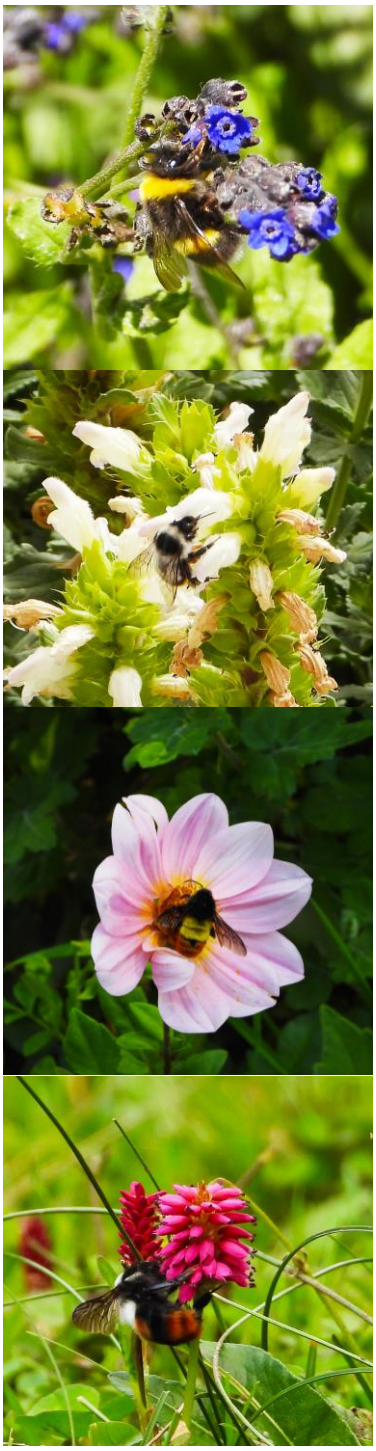


Background: This document compiles the present information about bumblebee declines and their management in Indian Himalayan Region (IHR). Bumblebees play a functional role in natural and agriculture ecosystems and constitute a key ecosystem service in maintenance of both wild and agriculture communities. Bumblebee provide regulating ecosystem services in the high-altitude region by pollination. Hymenopterans, particularly bees, pollinate more angiosperm plant species than any other taxa which makes this forth most pollinating order of class Insecta. Social bees (*Apis* and *Bombus*) are generalized flower-visitors who accumulate pollen loads to feed their offsprings and drink nectar to stoke up their foraging flight. Their aptitude to perform pollination at very low temperatures (-3.6 °C), long tongue length and perform buzz pollination is matchless. They draw on flower resources with deep corollas resulting in higher foraging rates.

Flowers comes in a variety of shape and forms some bee foragers find it east and some difficult to pollinate. The physical characteristics of flowers and ethology of pollinators play an integral part in effective pollination. Long-tongued insects are necessary for pollinating red clover (*Trifolium pratense*) because of their long corollas; long-tongued bumble bees happen to be more lucrative at this than honey bees. Bumble bees are frequently more efficient than honey bees at vibrationally offloading pollen from tomato anther to stigma during tomato pollination. Solitary bees work more quickly and have a greater inclination for alfalfa, they are better at pollinating alfalfa then honey bees. Bumble bees are the most significant agrarian pollinators among wild bees, and their populations rise with latitude. Compare to other bee families, they have wider flight seasons and an array of flowers. The variety of flowers that bumblebee species visit varies depending on their

morphological traits and habitat, such as their long and short tongue length (Corbet *et al.*, 1991).

Diversity: Of the 288 species of bumblebees recognized by taxonomists, approximately 62 occur in the Himalaya (Williams, 2022). In India, bumblebee occur only in western and eastern Himalaya. Williams, 2022, reported 56 bumblebee species from the Indian Himalayan region, adding to a number of *Bombus* species in recent years. 48 bumblebee species from IHR were described by Saini *et al.*, 2015, while 21 bumblebee species diversity was identified from Arunachal Pradesh by Streinze *et al.* in 2018. Raina et al., 2024 added one more species *B. cryptarum* to the National Bumblebee fauna. Presently, India is now represented 57 species of Bumblebees i.e. 20% of the world's bumblebee fauna. The local climate of the Himalaya varies greatly; e.g., eastern end experiences considerable yearly rainfall and usually constant temperatures, while the western end experiences strong annual temperature changes. (Williams *et al.*, 2010; Rawat, 2017). This pattern contradicts the overall trend of most plant and animal taxa, which show a reduction in diversity with increasing latitude. In India, the genus *Bombus* comprises ten subgenera. These are:



***Mendacibombus* (3 species)-** A medium tongue length bumblebees occurring in high alpine meadows visit mid-depth flowers.

***Subterraneobombus* (3 species)-** A long tongue bumblebee of semi cold desert to high alpine region visits deep flowers.

***Megabombus* (2 species)-** This is a wide-spread group occurring throughout the western and eastern Himalayan regions as well as central Himalayan region (Nepal) visiting deep flowers.

***Orientalibombus* (2 species)-** Frequently occurring at low elevations visiting deep flowers.

***Psithyrus* (7 species)-** They are found in meadows and forest areas. They parasitize other social *Bombus* species colonies and are also known as Cuckoo bees.

***Pyrobombus* (15 species)-** The largest group of IHR bees, occurring in mountain grasslands, forests and semi cold desert. They possess short length tongue and visit shallow flowers.

***Bombus* (5 species)-** Having underground nest with large colonies. Short length tongue occurring in mountain meadows and forest edges visit shallow flowers.

***Alpigenobombus* (6 species)-** Bumblebees of the alpine grassland and forest edges. Short to medium length tongue foraging shallow to medium flowers.

***Melanobombus* (12 species)-** A short or medium length tongue occurring at high alpine grasslands visiting medium flowers. Some species true territorial (e.g., *B. rufofasciatus*: Williams, 1991)

***Sibiricobombus* (2 species)-** A small group of long length tongue bumblebees found in high alpine grasslands and cold desert, forage deep flowers.

Zoological Survey of India, Desert Regional Centre, Jodhpur culminated a project on bumblebees entitled "Documentation, conservation and utilization of Indigenous Mountain pollinators- with special reference to Himalayan bumblebees" funded by NMHS, Almora Uttarakhand.

KEY FINDINGS OF THE PROJECT

Approach: The study areas include three Himalayan states- Himachal Pradesh, Arunachal Pradesh and Uttarakhand and two Union Territories- Jammu & Kashmir and Ladakh respectively. The collection performed using probability and opportunistic sampling methods. The collection was made with the help of sweep hand net made from nylon material and specially made glass jar poured with ethyl acetate fumes. Geo-coordinates collected using Garmin GPS handsets and documentation of live foraging bumblebee species, nesting site, topography, and host flowering plants were captured using a Digital Camera (Nikon Coolpix P1000). Enlisting of host plants of bumblebee fauna stirring at diverse altitudes of IHR. The collected samples brought to the lab for identification. After which specimens were dry mounted on entomological pins for identification. The bumblebees were observed in a Nikon SMZ25 microscope and identified with the help of available literature (Saini *et al.,* 2015, Williams, 2022). The collected specimens were deposited in NZC, ZSI, Jodhpur.

Observation and findings: From September, 2020 to September, 2022, sample collection of bumblebees was conducted in 10 districts of Jammu and Kashmir, 02 districts of Ladakh, 06 districts of Uttarakhand, 05 districts of Himachal Pradesh, and 03 districts of Arunachal Pradesh. This was achieved by exploring 355 targeted habitat localities using various sampling techniques. A total of 10,179 individuals of 36 bumblebee species from ten

subgenera and 25 species of other wild bees were reported during the study period. Subgenus *Melanobombus* were represented by a maximum number of nine species, followed by *Psithyrus* and *Pyrobombus* with five species while remaining subgenera *Bombus s.str.*, *Alpigenobombus* represented four species, *Sibricobombus*, *Mendacibombus* and *Subterraneobombus* represent two species and remaining two subgenera *Megabombus* and *Orientalibombus* represent one species each. Among ten subgenera of bumble bee, *Melanobombus* and *Bombus s.str.* were most abundant constitute major portion of total subgenus while *Orientalibombus* was least abundant. One species *Bombus cryptarum* recorded from Gurez valley for the first time from India.

The study has provided the following major outcomes (1) aids to help identification of bumblebee, as appropriate for target different audiences, ranging from village farmers groups to international specialist taxonomists; (2) established a permanent reference collection of identified and fully labelled and documented specimens for use as a resource by future pollinator projects; (3) established a huge database of Himalayan Bumblebees as a central repository for information that will be available to future projects; (4) prepared distribution maps of Himalayan bumblebee species as an online resource; (5) Organized workshops and distributing pamphlets of advice for farmers and growers to encourage improved practices for pollination in orchards and crops; (6) Documentation of the genera and species has increased our knowledge of the biodiversity of these bees in the study area.(7) identified the linkage between the bumblebees and their host plants by using SEM (Scanning Electron Microscopy) to examine the pollination attributes by identifying the pollen grains attached with Bumblebee body preferably on hind legs to identify the linkage with various food plants, field sizes, etc. (8)The inventory of 200 species of different angiosperm plants from the study area that were frequently visited by these types of bees for foraging and collecting nectar has been prepared.

Attacks by the exo-parasitic mite *Uropodina* sp. (Acari: Mesostigmata) on males of *Bombus miniatus,* queens of *Bombus simillimus,* and the viability of bumblebees affected by the mite population was also ascertained in Jammu & Kashmir and Himachal Pradesh. The queens of *B. simillimus* suffered significant attacks and *Uropodina* sp. were widely dispersed throughout the bumblebee body, affecting the queen's ability to fly, reproduce, feeding and maintain her health (Raina *et al.,* 2021). Individual bumblebees were seen feeding on various angiosperm plants from 50 distinct families over the project's duration. In the study area, more than 200 host plants have been identified to be present in states of agricultural,

grassland, forest habitat, and human habitation. Asteraceae, Lamiaceae and Rosaceae are dominant plant families recorded in the study area.

Results of this project will have long-lasting impact because the project has not only produced a report and a local community-outreach programme, but will feed into IUCN global Red List assessments. This will be especially important for several species which are endemic to India. The baseline data generated through this study is very useful for acquiring knowledge about pollinator diversity along the elevation gradient, different types of pollinators, and pollination strategies. This study is useful for various organizations, policymakers, ecologists, and growers to view and help in a better way to understand conservation practices, Biodiversity management, different agriculture practices, etc. The project will contribute towards assessing the current populations and threats to bumblebees in areas of the Himalaya that are known to have a rich bee fauna but where the conservation status and vulnerability of many species is unknown. It will be very valuable for supporting the assessment of their conservation status in one of their greatest hotspots of diversity world-wide.

Natural calamities like landslides, cloudburst, earthquakes, forest fire and floods etc. disturb the natural habitation of bumble bees leading to habitat fragmentation and species loss in the Himalayan region. Anthropogenic activities such as pollution, use of pesticides, herbicides, and fertilizers, overexploitation of natural resources, climate change, steadily increasing population in the hotspot has led to extensive clearing of forests and grasslands for cultivation and widespread logging.

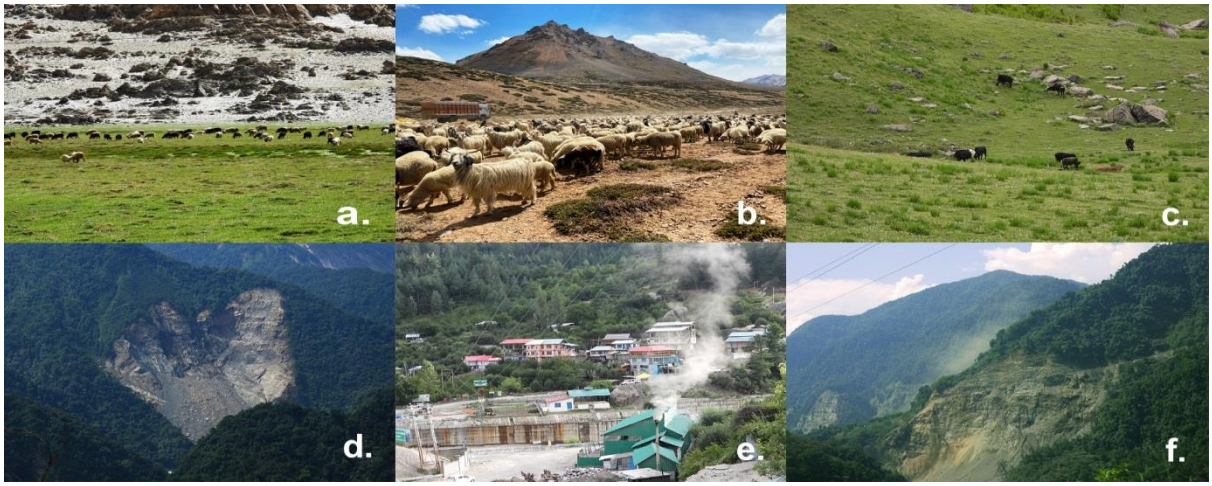
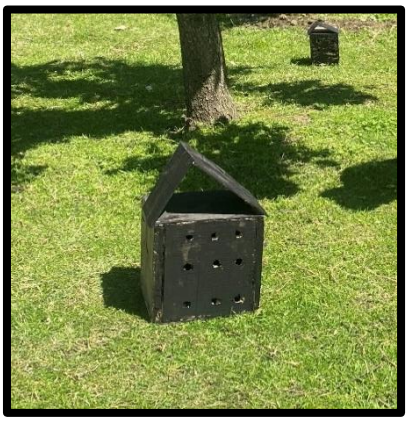


Figure 1: Overgrazing by cattle, sheep and goats in grassland landscape in (a) Ladakh, (b) Himachal Pradesh, (c) Uttarakhand; (d) Landslide; (e) Pollution arising from stone crushers; (f) Logging for transport construction.



Recommended Policy Strategies

The following policy areas are recommended for indigenous bee conservation in Indian Himalayan region.

1. **Adopt chemical free approach that is friendly to pollinators**

Certain chemicals, such as herbicides, insecticides, and fungicides, can harm wild bees directly or indirectly. By destroying plants that serve as food sources and nesting materials, certain herbicides have an indirect effect on pollinators. Regulatory strategies for mitigating pesticide use include:

- ✓ Pesticides known to be hazardous to wild bees should be severely restricted or banned. Another strategy to control pesticide use is to limit pesticide applications through the enactment of a licensing or permitting process.
- ✓ Information regarding pesticide toxicity to wild bees and other pollinators, as well as suggestions for risk mitigation, should be included on labels. Labels have to disclose the toxicity to native pollinators.

2. **Protect and improve pollinator habitats**

In order to protect wild bees and ensure that highland crops are pollinated, it is crucial to preserve current habitats and restore newly created ones. As a part of project activity 45 artificial nests of indigenous bees in the surveyed area developed and has simultaneously demonstrated pollination management strategy to farmers and growers for improved practice in pollination in their orchids and crops.

Over 200 species of food plants are primarily conserved by wild bees at higher elevations and elevations where other insect activity is very limited.

- ✓ Priority Conservation Sites (PCS) in the Indian Himalayan Region is recommended to study the diversity, species distribution, pollination, nesting behavior, foraging, disease and cold tolerance. The PCS are Zanskar, Karakoram, Gurez valley, Sela Pass, Mishimi Hills, Nanda Devi and Spiti valley.
- ✓ Studies on plant-bee interactions in the high-altitude regions of Himalaya up to perennially frozen ground so that protection and preservation of the rarest type of angiosperm gene flow possible.

3. **Ensure involvement & strengthening of various stakeholders, such as native and rural people**

In order to reverse the pollinators chaos, public outreach, awareness building, and utilizing local knowledge are essential components. Native and rural people possess valuable information about pollinators and biodiversity conserving farming methods in many parts of the world.

- ✓ 42 outreach/awareness activities were carried out at village/municipality level in the UT of Jammu & Kashmir, UT of Ladakh, Himachal Pradesh, Uttarakhand, Arunachal Pradesh regarding the conservation and utilization of indigenous bees.
- ✓ The project team simultaneously demonstrated a pollination management strategy to more than 400 farmers and growers for improved practice in pollination in their orchid and crops.
- ✓ A booklet of advice to farmers and growers has been distributed as part of their demonstration program.

4. **Encourage cooperative research and training**

- ✓ Invest into research and establish database for studies of wild bees.
- ✓ Train research fellows, scientists on identification, field survey and pollinator protection.
- ✓ Enhance financial assistance for studies on wild bees and their importance in high altitude region.
- ✓ High land pollinators, majorly the bumblebees, should be taken into considerations when formulating the policies related to Infrastructural development, conservation and management of ecosystems, agricultural productivity etc.
- ✓ Environmental Impact Assessment (EIA) related studies should also include the Bumblebees.
- ✓ Such type of studies should continue in other parts of the IHR to develop a consolidated data base on the species of bumblebees involved in pollination.

Table 1: Conservation status of bumblebee species (Preliminary assessment)

S.N.	Scientific Name	Subgenus	IUCN status
1.	*Bombus novus* (Frison, 1933)	*Psithyrus*	
2.	*Bombus abnormis* (Tkalcu, 1968)	*Pyrobombus*	Endemic
3.	*Bombus mirus* (Tkalcu, 1968)	*Pyrobombus*	Endemic
4.	*Bombus luteipes* (Tkalcu, 1968)	*Pyrobombus*	Endemic
5.	*Bombus pressus* (Frison, 1935)	*Pyrobombus*	Endemic
6.	*Bombus parthenius* Richards, 1934	*Pyrobombus*	Endemic
7.	*Bombus tunicatus* Smith, 1852	*Bombus*	Endemic
8.	*Bombus jacobsoni* Skorikov, 1912	*Melanobombus*	Endemic
9.	*Bombus miniatus* Bingham, 1897	*Melanobombus*	Endemic
10.	*Bombus simillimus* Smith, 1852	*Melanobombus*	Endemic

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