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Caption: *Cyrtodactylus myntkyawthurai*, endemic to Myanmar. Medium: Water colours on watercolor sheet. © Aakanksha Komanduri



## Associations of butterflies across different forest types in Uttarakhand, western Himalaya, India: implications for conservation planning

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**Abstract:** Champion & Seth classified Indian forests into different ‘forest types and sub-types’, based on similarity of dominant vegetation and structural arrangement of species in each. However, it is not known if the species composition and community structure of butterflies is also different in each forest sub-type. If this is the case then each forest sub-type harbouring unique species can be taken as units of conservation on a sub-regional scale. The present study assesses for the first time the species composition and community structure of butterflies across 20 different and prominent ‘forest sub-types’ found across the state of Uttarakhand, western Himalaya. Data collected over eight years (2006–2009; June 2012; 2017–2020) using random seasonal sampling covering 307 transects revealed 370 butterfly taxa. Hierarchical clustering of butterfly abundances revealed seven different butterfly communities spread over 19 forest subtypes. Of these four forest sub-types (3C/C2a moist Shiwalik sal forest; 12/C2c moist temperate deciduous forest; 12/C1a ban oak forest; & 3C/C2c moist Terai sal forest) were identified as most important as they hold most of the butterfly diversity of the state including 58 rare taxa identified according to ‘rarity’ out of the total. GIS based mapping of these 58 priority species over laid on the protected area network and forest cover distribution in the state revealed many forested sites outside the PA network supporting these rare taxa. These sites along a physiogeographical gradient with important forest sub-types and rare taxa can be recommended and listed as new sites for conservation in the state.

**Keywords:** Ban Oak, butterfly, protected area network, physiogeography, rarity, tropical moist deciduous forest, vegetation.

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## INTRODUCTION

Butterflies, amongst invertebrates, are suitable indicators for ecological studies (Lomov et al. 2006), as the taxonomy, geographical distribution and status of many species are relatively well known (Pollard 1977; Thomas 1983; Thomas & Mallorie 1985; Murphy & Wilcox 1986). They are phytophagous, primary herbivores, good pollinators and surrogates plant diversity living close by their food plants (Ehrlich & Raven 1964; Gilbert & Smiley 1978; Pyle 1980). The precise and restricted environmental requirements of particular butterflies make them of considerable value as a group of indicator taxa that indicate the broader effects of environmental changes or reflects a particular suite of ecological conditions or habitat heterogeneity (Pyle 1980; Gilbert 1980, 1984; Brown 1982; Rosenberg et al. 1986; Murphy et al. 1990; New 1991; Kermen 1992; Pearman et al. 1995). Strong association with vegetation structure and composition makes Lepidoptera a particularly useful bioindicator for monitoring eco-restoration programs (Kremen et al. 1993; New et al. 1995).

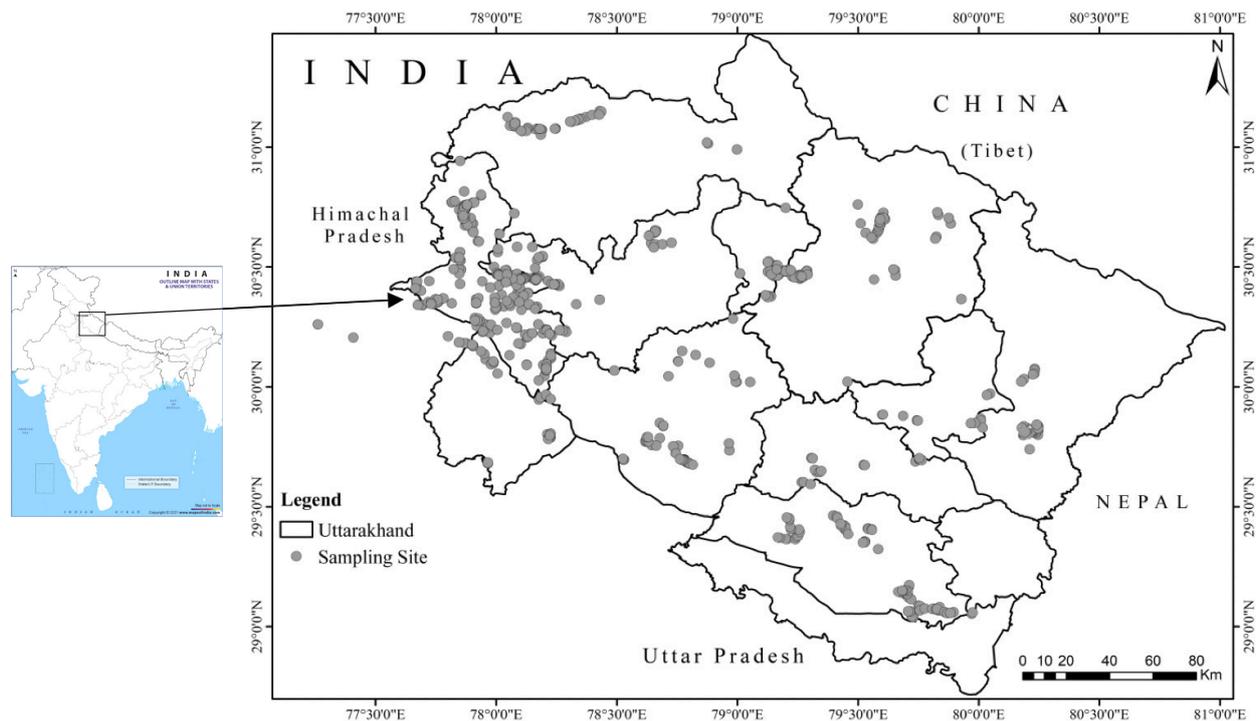
Habitat is an important requisite for the proliferation and conservation of a butterfly species (Gilbert & Singer 1975), as species prefer particular habitats, closely related to their life history, breeding, larval and adult food resources and destruction of forest severely affects species habitats (Wells et al. 1983) and many species which were once common become rare. Thus, identification and conservation of priority landscapes, is very important. Champion & Seth (1968) classified Indian forests into different 'forest types' their sub units as 'forest sub-types', based on the similarity of dominant vegetation and structural arrangement of species within each of them, i.e., 'IV montane temperate forest' is one of VI major 'forest types' found across India (other 5 categories being "I. moist tropical forests, II. dry tropical forests; III montane subtropical forests; V sub-alpine forests, and VI alpine forests" classified by Champion & Seth (1968)), while its lowest unit in the hierarchy is a 'sub-type', e.g., "12C<sub>1</sub>/1a Ban oak forest" (Here, '12' signifies "12 Himalayan moist temperate forest" in a group of three [the other two being 11 Montane wet temperate forests & 13 Himalayan dry temperate forests). Then further sub-division of this sub-group "12" into three groups: C<sub>1</sub>–C<sub>3</sub>, where "C<sub>1</sub>" signifies "C<sub>1</sub> lower western Himalayan temperate forest" (other 2 being "C<sub>2</sub> upper west Himalayan temperate forest" and "C<sub>3</sub> east Himalayan temperate forest") and lastly its last sub-division which is depicted as "1a", i.e., "1a Ban oak forest (*Q. incana*)" (*Quercus incana* = *Q. leucotrichophora*)

amongst the set of two (the other being "1b Moru oak forest (*Q. dilatata*)" (*Quercus dilatata* = *Q. floribunda*) (Champion & Seth 1968)]. In this way, different 'forest subtypes' have been classified and labelled in India.

However, it is not known if the species composition and community structure of lower groups of animals such as butterflies are also different within each 'forest-sub-type' or each have a unique community of butterflies. If this is the case then each forest sub-type harbouring unique and rare species can be taken as a unit of conservation on a sub-regional scale (western Himalaya) or state level (Uttarakhand). In this study we tried to evaluate and examine potential 'forest sub-types' or 'a group of forest sub-types' that have unique butterfly diversity which can be taken up as units of conservation of biodiversity at the state level. Besides, this can also be helpful in identification of new conservation areas with forest habitats outside the PA network and thus fill gaps in their connectivity, in the state. The rationale behind this is that many butterfly species are restricted to forested habitats in the state, have geographical distribution spread across the Himalayan region, i.e., western, central, and eastern Himalaya along a wide altitudinal gradient, e.g., Pale Green Sailer *Neptis zaida zaida* Doubleday, [1848] or Broad-banded Sailer, *N. sankara sankara* (Kollar, [1844]) (Nymphalidae) both occur in the state between 800–2,500 m, as observed in the present study. Fragmentation of their forested habitats on a larger spatial and temporal scale, may lead to isolated populations, local extinctions that can significantly affect their distribution, as they do not migrate. Thus, gaps and connectivity of the protected areas needs to be maintained for long term conservation.

## STUDY AREA

The study was carried out in Uttarakhand state of India which covers an area of 53,483 km<sup>2</sup>, which is 1.63% of the geographical area of the country, and lies between 28.716–31.466 N latitude & 77.566–81.05 E longitude. This predominantly mountainous state, shares its borders with Himachal Pradesh to the west and Uttar Pradesh to the south. It also shares international borders with Nepal in the east and China (Tibet) to the north. The state is mainly representative of the western Himalaya, the climate and vegetation vary greatly with altitude, from glaciers at the highest elevations, and temperate to subtropical at the lower elevations. Nanda Devi peak is the highest point at 7,816 m in the state while the lowest areas at ~100m lie in the Terai grasslands.



**Figure 1.** GPS locations of sampling sites for study on butterflies undertaken during 2006–2009, June 2012 & 2017–2020 in Uttarakhand state of India.

The average annual rainfall is 1,500 mm and the annual temperature varies from below 0° C to 43° C. Major rivers, Ganga, Yamuna, Ramganga, & Sharda, drain the state along with their tributaries. The Himalayan range in Uttarakhand is divided into the distinct non-montane and montane physiographic zones. The lower zone comprises the ‘Bhabhar’ region in non-montane lowland woodlands having Gangetic moist deciduous forests and the Terai region (below 500 m) running parallel to it, which comprises mainly the marshes and grasslands (Botanical Survey of India 2021). The montane region is divided into sub-Himalaya, which consists of the Shiwalik ranges, the lower Himalayan ranges, and the Doon (flat long valleys) lying north of the Shiwaliks (~ 500–1,000 m). Above this region are the lesser Himalaya (~ 1,000–3,000 m) followed mid Himalaya (~ 3,000–4,000 m) and then greater Himalaya (~ 4,000–6,000 m) (Khanduri et al. 2013) and the trans-Himalaya (above 5,000 m), also known as the Tethys Himalayas and the Indo-Tibet plateau, the region is in the rain shadow area that transforms into the cold desert.

Forests cover an area of 24,303.04 km<sup>2</sup> in the state, which constitutes 45.44% of the state’s geographical area (FSI 2019). The state is represented by biogeographic zone 2B western Himalaya and 7B Shiwaliks of India (Rodgers & Pawar 1988). The state is rich in biodiversity

having about 102 species of mammals, 692 birds (<https://ebird.org/region/IN-UL>), 13 amphibians & 53 reptiles (Vasudevan & Sondhi 2010), and 124 fishes (<https://forest.uk.gov.in/wildlife-management>). Some of the globally endangered fauna like the Asiatic Elephant *Elephas maximus*, Snow Leopard *Panthera uncia*, Tiger *Panthera tigris*, Leopard *Panthera pardus*, Musk Deer *Moschus chrysogaster*, Swamp Deer *Rucervus duvaucelii*, Cheer Pheasant *Catreus wallichii*, and the King Cobra *Ophiophagus hannah* are found in the state. Uttarakhand shelters around 4,000 species of plants, belonging to 1,198 genera, under 192 families, of which ~34 species have been listed as threatened (Nayar & Sastry 1987, 1988, 1990; <https://indiabiodiversity.org/>). The PA network cover 12 percent of the total geographical area of the state, which includes six national parks, seven wildlife sanctuaries, four conservation reserves, and one biosphere reserve (Appendix 1).

**Previous studies on butterflies in Uttarakhand**

Studies on natural history and checklists of different areas in Uttarakhand state have been carried out as early as 1886 (Doherty 1886; Mackinnon & de Nicéville 1899; Hannington 1910–11; Ollenbach 1930; Shull 1958, 1962; Baidur 1993; Smetacek 2002, 2004, 2012; Bhardwaj et al. 2012; Bhardwaj & Uniyal 2013; Singh &

Bhandari 2003, 2006; Singh & Sondhi 2016; Verma & Arya 2018; Sondhi & Kunte 2018; Singh & Singh 2021) and the total number of butterfly species recorded in the state so far is ~ 500 species, based on these records. However, none of these studies give an account on the association of butterfly species with different forest sub-types as classified by Champion & Seth (1968), found across the state of Uttarakhand. The author had earlier studied butterfly-forest type associations in 11 major “forest sub-types” in the state of Arunachal Pradesh (eastern Himalaya), India (Singh 2017) and identified four forest sub-types: 2B/1S1 sub-Himalayan light alluvial plains semi-evergreen forests; 2B/C1a Assam alluvial plains semi-evergreen forests; 2B/2S2 eastern alluvial secondary semi-evergreen forests, and 3/1S2 b Terminalia-Duabanga as major forest sub-types supporting 415 butterfly taxa along with many rare and endemic species in the northeastern region and eastern Himalaya, but the forest sub-types occurring in these two Himalayan states are totally different from each other.

## METHODS

Random sampling surveys were carried out for eight years under two different projects (2006–2009 and 2017–2020, respectively) across 11 districts of Uttarakhand state covering all the six butterfly seasons (spring, summer, pre-monsoon, monsoon, post-monsoon, autumn, and winter; Smith 1989) of the year. Surveys were carried out using ‘Pollard Walk’ on the line transects (Pollard & Yates 1993). Sampling on each transect (ca. 1 km) was done and butterflies were observed up to 20 m on both the sides of the trail for 1 h in a stretch between 1000 h and 1600 h to collect data on individual butterfly species abundance. Each sampling survey was carried out by the author, while 1–2 helpers were also used for recording data, collection of insect and plant material from time to time. Coordinates of all the locations for 307 samplings carried out were recorded using a GPS (Étrex Garmin Vista) (Figure 1) covering 20 major forest sub-types (FSI 2011; Figure 2 & Appendix ii) existing across the state of Uttarakhand.

Identification and distribution range of each taxa was assessed based on published literature (Moore 1874, 1890–1992, 1893–1896, 1896–1899, 1899–1900, 1901–1903, 1903–1905; Swinhoe 1905–1910, 1910–1911, 1911–1912 & 1912–1913; Bingham 1905; Talbot 1939, 1947; Evans 1932; Wynter-Blyth 1957; D’Abrera 1982, 1985, 1986; Haribal 1992; Smith 1989, 2006;

Kehimkar 2008, 2016; Singh 2011; Smetacek 2015; Gasse 2017; Sondhi & Kunte 2018) and websites (<http://www.ifoundbutterflies.org/> and <http://flutters.org/>). Comparison of a few specimens was also done with specimens at the National Forest Insect Collection (NFIC) at Forest Research Institute, Dehradun, Uttarakhand, India, for identification.

Dominant vegetation (mainly trees & shrubs) in the respective forest sub-types were also identified and confirmed by ground truthing by laying down 10 x 10 m quadrates, collected plant material and preparing herbariums. Photographs and herbarium specimens were identified in the field and many were identified and confirmed from plant taxonomists based at Systematic Botany Branch, Botany Division, FRI, Dehradun and literature (Brandis 1906; Rai et al. 2017; <http://www.gbif.org>).

## Evaluating species of conservation priority: rarity analysis of butterflies

The degree of “rarity” characterizing a species is usually an indicator of extinction risk (Rabinowitz et al. 1986; Pimm et al. 1988; Arita et al. 1990; Primarck 1993; Gaston 1994; Brown 1995; Gaston & Blackburn 1995) and provides a basis to identify threatened species (Rabinowitz 1981; Arita et al. 1990; Daniels et al. 1991; Berg & Tjernberg 1996). In general, species characterized by small geographic range, habitat specialization, and low abundance, are at higher risk of extinction than a widely distributed, habitat generalist and with high abundance. Rabinowitz et al. (1986) have examined types of rarity, and in what important ways rare species differ from one another. They first distinguish three traits, characteristic of all taxa recorded: (i) Geographical range - whether a species occurs over a broad area or whether it is endemic to a particular area; (ii) Habitat specificity - the degree to which a species occurs in a variety of biotopes’ or ‘habitats’ is restricted to one or a few specialized sites versus generalists; and (iii) Local population size - whether a species occurs in large populations somewhere within range or has small populations whenever it is found.

In the present study, Rabinowitz et al. (1986) classification of rarity based on the three above traits was used. Only those species were filtered out the total as rare which had: (i) narrow geographical range, i.e., those species which had narrow distribution restricted only to western and central Himalaya as against those with wide distribution, i.e., Himalaya, northeastern India, & Peninsular India; (ii) restricted to two or less forest sub-types as against more than two forest sub-

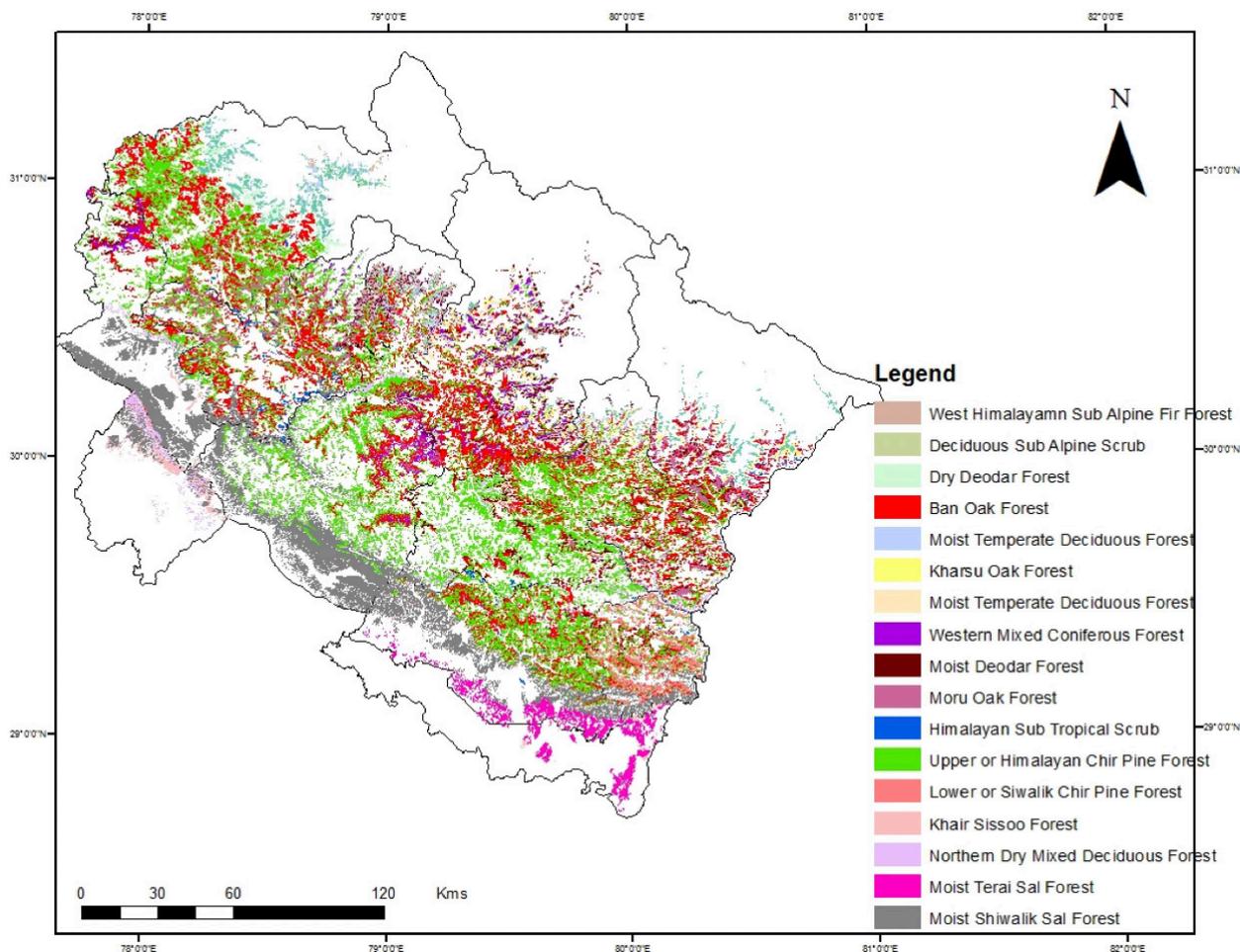


Figure 2. Distribution of major forest types surveyed in Uttarakhand.

types; and (iii) having small local population size across their distribution range, i.e., those taxa which were classified as ‘very rare’, ‘rare’, and ‘not rare’ by Evans (1932) and Kehimkar (2008), as against ‘fairly common’, ‘common’, and ‘very common’.

**Hierarchical clustering of different forest sub-types based on butterfly species distribution and relative abundance.**

The data of relative abundance of all the species of butterflies sampled against 20 different forest sub-types was pooled and averaged to relative abundance per sampling in each of the forest sub-type to remove varied sampling bias and was done using statistical software “NCSS Data Analysis 2021, v21.0.2”, to know the dissimilarity of forest sub-types in terms of butterfly species composition.

**RESULTS AND DISCUSSION**

The field surveys revealed 370 butterfly taxa (Papilionidae (31); Pieridae (32); Nymphalidae(138); Lycaenidae (97); Hesperiiidae (62) and Riodinidae (7); see appendix.iii), which accounted to ca 75% of the species recorded from the state so far. If we exclude ~ 40 historic records (Singh & Sondhi 2016; Sondhi & Kunte 2018), then it totals to 80% of the total species found in the state. The study also reported new range extensions from central and eastern Himalaya, i.e., Dark Sapphire (Singh & Seal 2019); Scarce Lilacfork *Lethe dura gammiei* (Moore, [1892]) (Singh & Singh 2019), Dubious Five ring *Ypthima parasakra parasakra* Eliot, 1987 (Singh & Singh 2022) and records like White-ringed Meadowbrown, *Hyponephele davendra davendra* (Moore, 1865) (Singh & Singh 2021), Pale Jezebel *Delias sanaca sanaca* (Moore, [1858]) (Singh 2016); Mountain Tortoiseshell *Aglaia rizana* (Moore, 1872) (Singh & Singh 2019); White-wedged Woodbrown *Lethe dakwania* Tytler, 1939

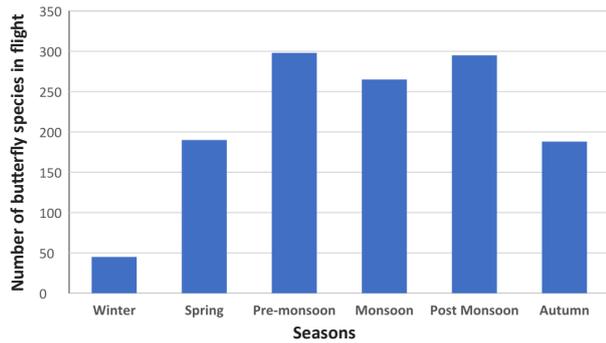


Figure 3. Seasonality of butterflies in Uttarakhand.

(Singh & Singh 2021), to the state. Some rare records like Garhwal Swordtail *Graphium garhwalia* (Katayama, 1988), Highbrown Silverspot, *Argynnis jainadeva jainadeva* Moore, 1864; Regal Apollo, *Parnassius charltonius* Gray, [1853] and new range extensions (Red-tailed Forester, *Lethe sinorix sinorix* (Hewitson, [1863]) and Nepal Comma *Polygonia c-album cognata* Moore, [1899]) are reported in this paper.

The relative abundance of species ranged 1–1,596 individuals. These species were then ranked into four abundance classes based on their quartile division, i.e.,

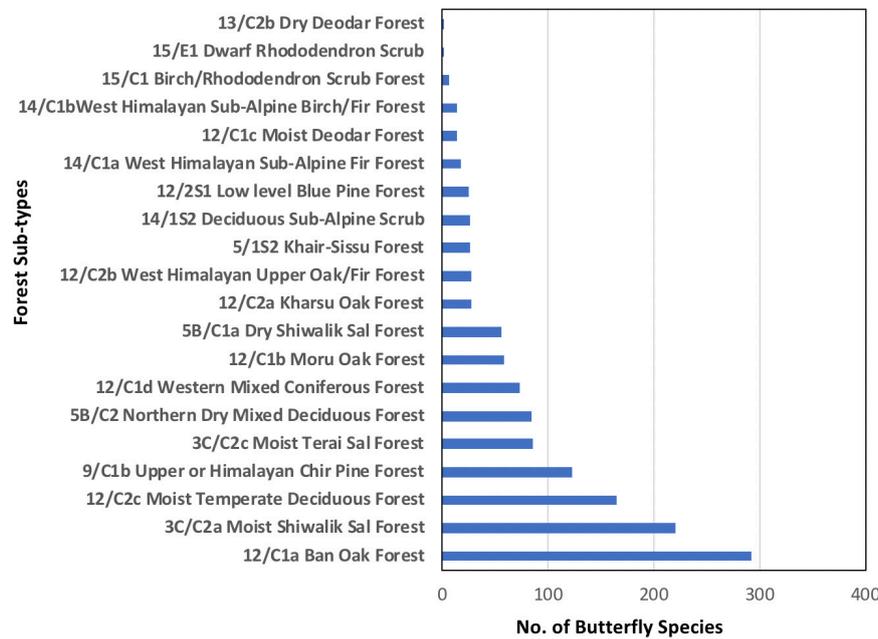


Figure 4. Relative distribution of butterfly species in different forest sub-types in Uttarakhand.

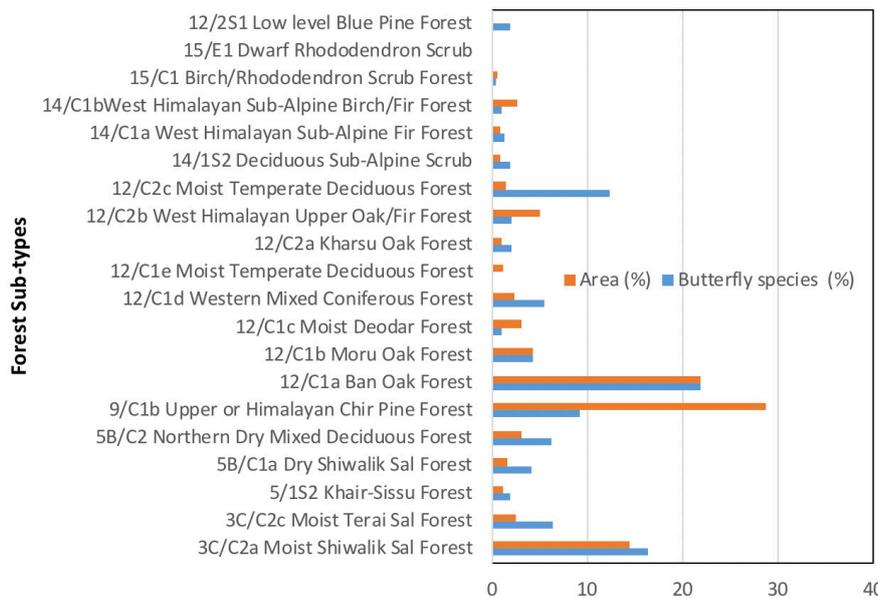


Figure 5. Percentage of butterfly species in each forest sub-type in relation to the proportional area covered by each forest sub-type in Uttarakhand.

Q1= 1–7 Uncommon (1= rare); 8–21= Fairly Common; 22–69 = Common; 70–1,596 = Very Common Median= 21 (Table 4 and an “Appendix iii” with an account of 370 taxa). Sixty-seven species sampled are listed under various schedules of the Indian Wildlife Protection Act, 1972 (appendix: Schedule I—8 species; Schedule II—51 & Schedule IV—8). The seasonality of butterflies suggests that most of the species are in flight during ‘post-monsoon’ and ‘pre-monsoon’ seasons followed by ‘monsoon’ season, respectively when more than 270 species are in flight (Figure 3) in the state.

The pattern of seasonality in Uttarakhand is very similar to the trend found in western and central Himalaya (Wynter-Blyth 1957) where two peaks are known to occur in a year, the bigger one during the ‘post-monsoon’ season and a slightly smaller one during the ‘pre-monsoon’ season.

### Preference for Forest Sub-types

The highest number of species were recorded in 12/C1a Ban Oak Forest (292 species; Fig.4) followed by 3C/C2a Moist Shiwalik Sal Forest (220) and 12/C2c Moist Temperate Deciduous Forest (165), respectively which suggests that these forest sub-types hold the major diversity of butterflies found in the state. The number of species sampled were the least in 13/C2b Dry Deodar Forest (14), 15/C1 Birch Rhododendron Scrub (6) and 15/E1 Dwarf Rhododendron Scrub (2), respectively (Figure 4) suggesting them to be poor butterfly habitats, while the other 14 forest sub-types lay between them.

The percentage of butterfly species in each forest sub-type in relation to the proportional area covered by each in the state (Figure 5), suggests that forest sub-types: 9/C1b Upper or Himalayan Chir Pine Forest; 12/C2b West Himalayan Upper Oak/Fir Forest and 14/C1 B Western Himalayan Sub-alpine Birch/Fir Forest, support a relatively lower number of butterfly species per unit area as compared to the rest of the other forest sub-types (Figure 4). On the other hand forest sub-types: 3C/C2 Moist Shiwalik Sal Forest; 12/C1a Ban Oak Forest; 12/C2C Moist Temperate Deciduous Forest and 12/C1d Western Mixed Coniferous Forest have a relatively higher density of butterfly species per unit area amongst all the forest sub-types covered (Figure 5). The primary reason for this is that pure conifer forest stands support less diversity of butterflies as compared to the pure broad leaved or mixed conifer-broad leaved forests, as the diversity of nectar and larval food plants available are more diverse in the latter two than in the former.

### Hierarchical clustering of forest sub-types

It was found that 7 forest-types butterfly clusters, 5 independent forest-subtypes and 2 clusters of 2 and 11 forest sub-types, respectively exist in the state (Fig.6). These are

1. 3C/C2a Moist Shiwalik Sal Forest.
2. 12/C2c Moist Temperate Deciduous Forest
3. 12/C1a Ban Oak Forest.
4. 3C/C2c Moist Terai Sal Forest
5. 9/C1b Upper or Himalayan Chir Pine
6. 5B/C2 Northern Dry Mixed Deciduous Forest & 5B/C1a Dry Shiwalik Sal Forest.
7. 12/C1b Moru Oak; 12/C2b Western Himalayan Upper Oak Forest/Fir; 12/C1d Western Mixed Coniferous; 12/2S1 Low Level Blue Pine; 12/C2a Kharsu Oak Forest; 14/C1a West Himalayan Sub-alpine Fir; 14/C1 Best Himalayan Sub-alpine Birch/Fir/ 14/1S2 Deciduous Sub-alpine Scrub & 15/C1 Birch/Rhododendron Scrub.

The dendrogram (Figure 6) suggests that the butterfly community of 3C/C2a Moist Shiwalik Sal Forest is totally distinct from that of 12/C2c Moist Temperate Deciduous Forest and 12/C1a Ban Oak forest. While 12/C1a Ban Oak Forest and 12/C2c Moist Temperate Deciduous Forest show greatest similarity. While diversity of 5B/C2 Northern Dry Mixed Deciduous Forest and 5B/C1a Dry Shiwalik Sal is different from that of 3C/C2c Moist Terai Sal Forest or 3C/C2a Moist Shiwalik Sal Forest. Eleven forest sub-types show another cluster being distinct from other groups (Figure 6). Four forest sub-types that are most important in the state in terms of number of both butterfly species and with distinct dissimilarity of butterflies are 3C/C2a Moist Shiwalik Sal Forest; 12/C2c Moist Temperate Deciduous Forest; 12/C1a Ban Oak Forest and 3C/C2c Moist Terai Sal Forest.

### Species preference of forest sub-types

Scatter plot (Figure 7) of individual butterfly species (n= 370) suggests that only one generalist species (Painted Lady *Vanessa cardui*) had preference for all 14 forest sub-types. While the number of species showing preference for more than five or more forest sub-types were fewer as compared to species showing preference for less than four forest sub-types (Figure 7 Horizontal bars) in the state. The maximum number of species showed preference for two forest sub-types (n= 90 species) followed by preference for only one forest sub-type (n= 60 species). This suggests that a large number of habitat specialist species exist in the state.

Butterfly abundance linkages between forest sub-types.

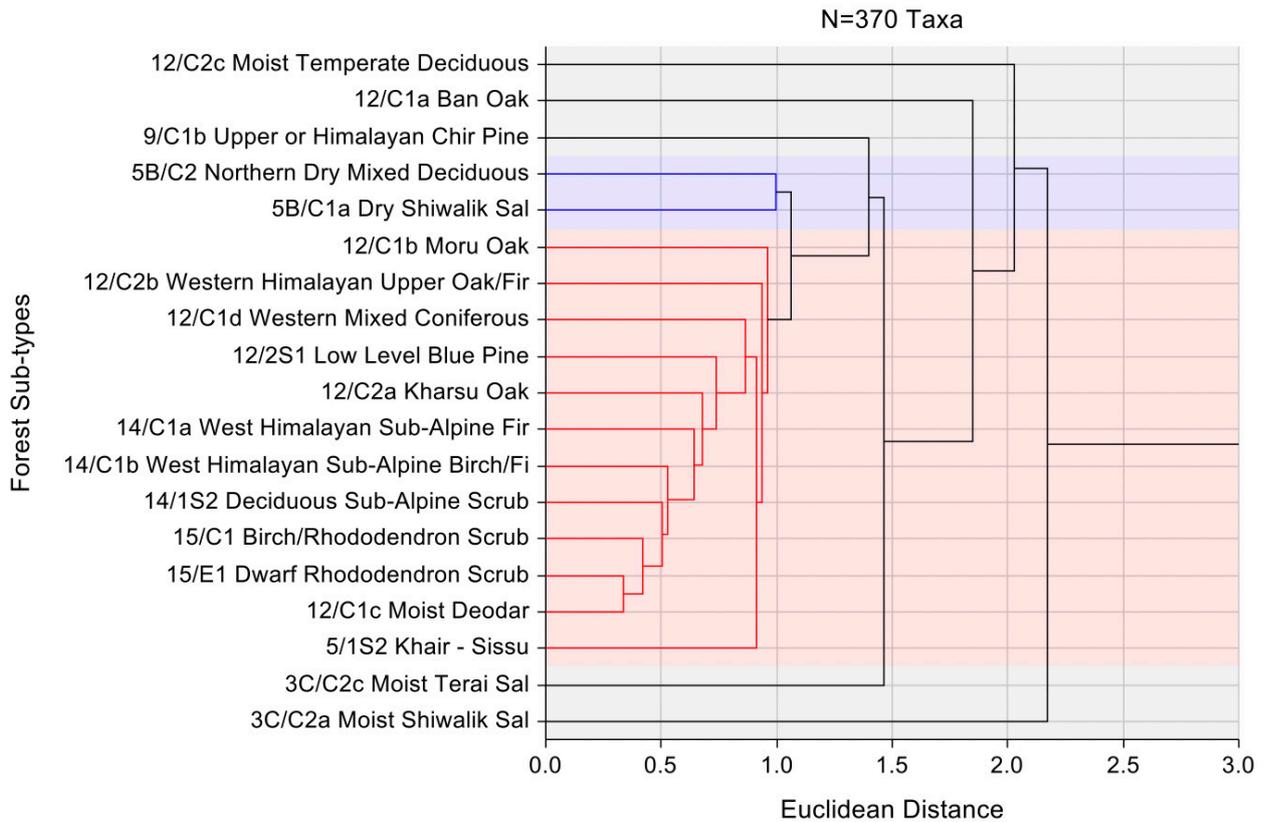


Figure 6. Dendrogram showing hierarchical clustering of forest sub-types in terms of butterfly species in each.

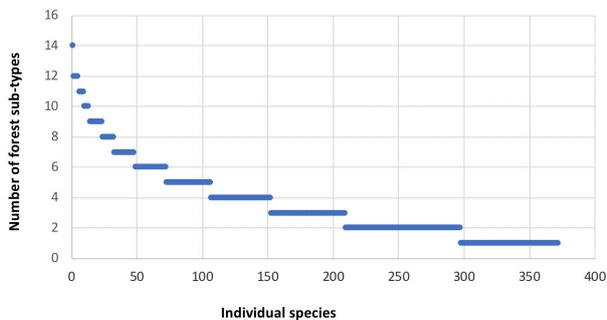


Figure 7. Preference of forest sub-type/s by individual species.

**Rarity in butterflies sampled in Uttarakhand: taxa of conservation priority**

Out of the 370 taxa sampled in Uttarakhand, 58 were evaluated as rare species of conservation priority /concern based on rarity analysis (Rabinowitz 1981; Rabinowitz et al. 1986) (Appendix IV).

The 58 taxa of conservation concern evaluated based on rarity are scattered all across the state in at least 12 forest sub-types (Figure 8). It was also determined that

most of the butterfly taxa of conservation priority occur in 12/C1a Ban Oak Forest followed by 12/C2c Moist Temperate Deciduous forest, 3C/C2 Moist Shiwalik Sal Forest and a few taxa in 12/C2b Western Himlayan Upper Oak/Fir Forest; 12/C1d Western Mixed Coniferous Forest, respectively (Figures 8–15).

The present study proved that individual ‘forest sub-types’(Champion & Seth 1968) or a group of ‘forest sub-types’ having high species richness, unique and rare butterfly taxa can be taken up as units of conservation at the state level in the Himalayan region as representatives of lower groups of animals, i.e., butterflies. Three most important forest sub-types: 12/C1a Ban Oak Forest followed by 12/C2c Moist Temperate Deciduous Forest and 3C/C2 Moist Shiwalik Sal Forest, respectively, hold the maximum number of butterflies, including many rare and protected taxa, in the state amongst the 20 forest sub-types evaluated, thus they form priority over the rest.

The 58 butterfly taxa conservation priority in the state lies both within and outside the PA network, but mainly in forested areas (Figure 16). Concentrations

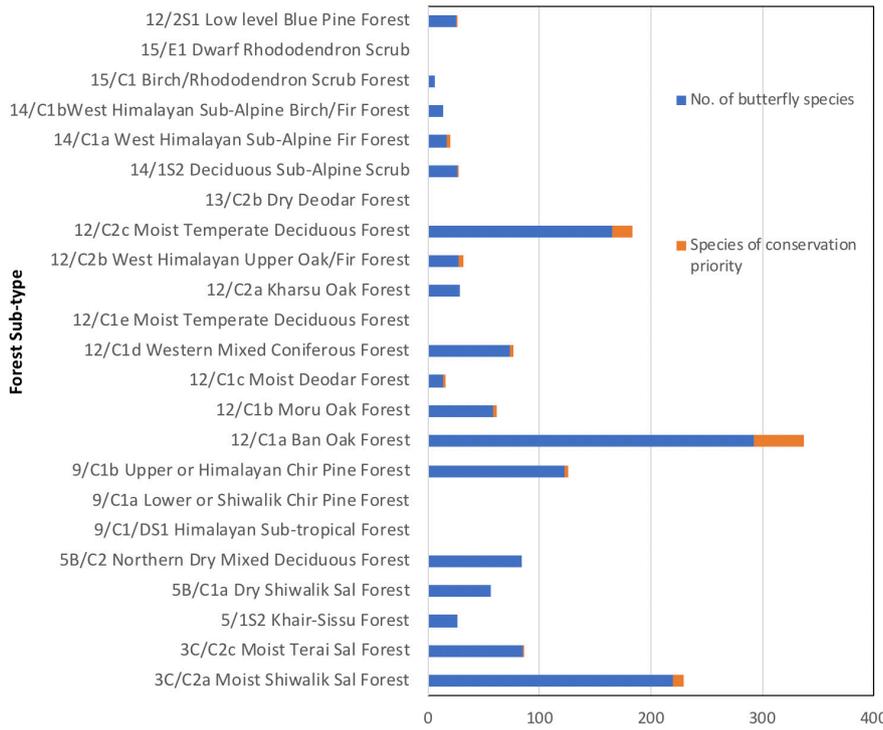


Figure 8. Spread of species of conservation priority species (orange bars) in different forest sub-types in relation to the total number of species sampled in them.

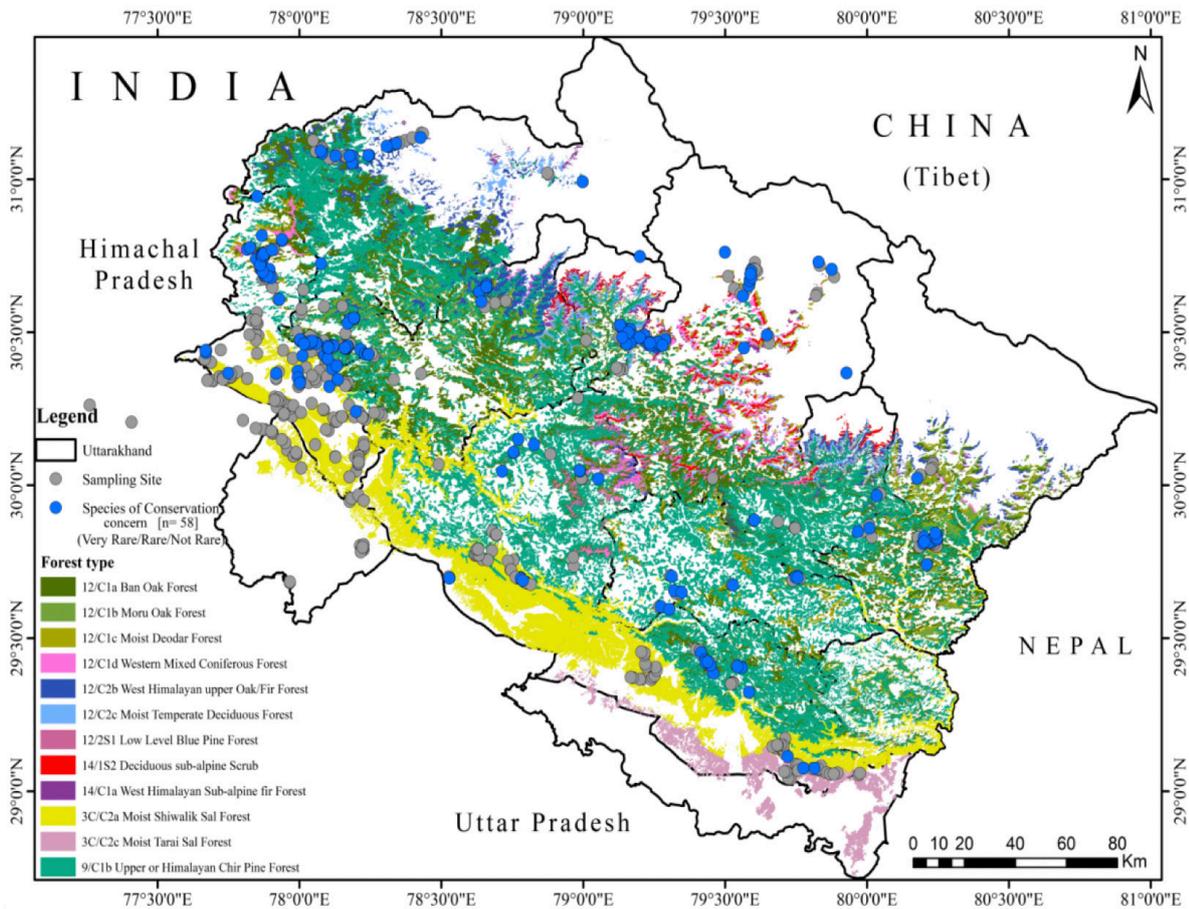


Figure 9. Map depicting the locations recorded for 58 species of conservation priority in 12 different forest sub-types across Uttarakhand.

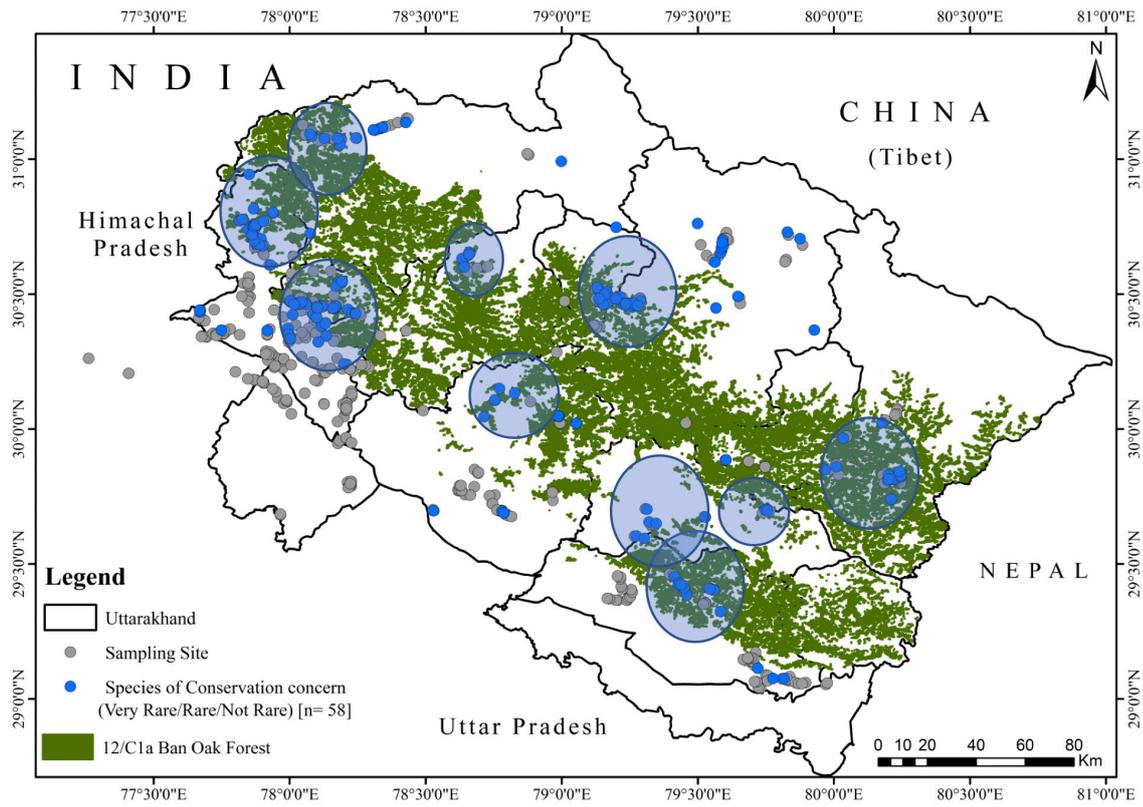


Figure 10. Important clusters of sites holding species of conservation priority in 12/C1a Ban Oak Forest in Uttarakhand.

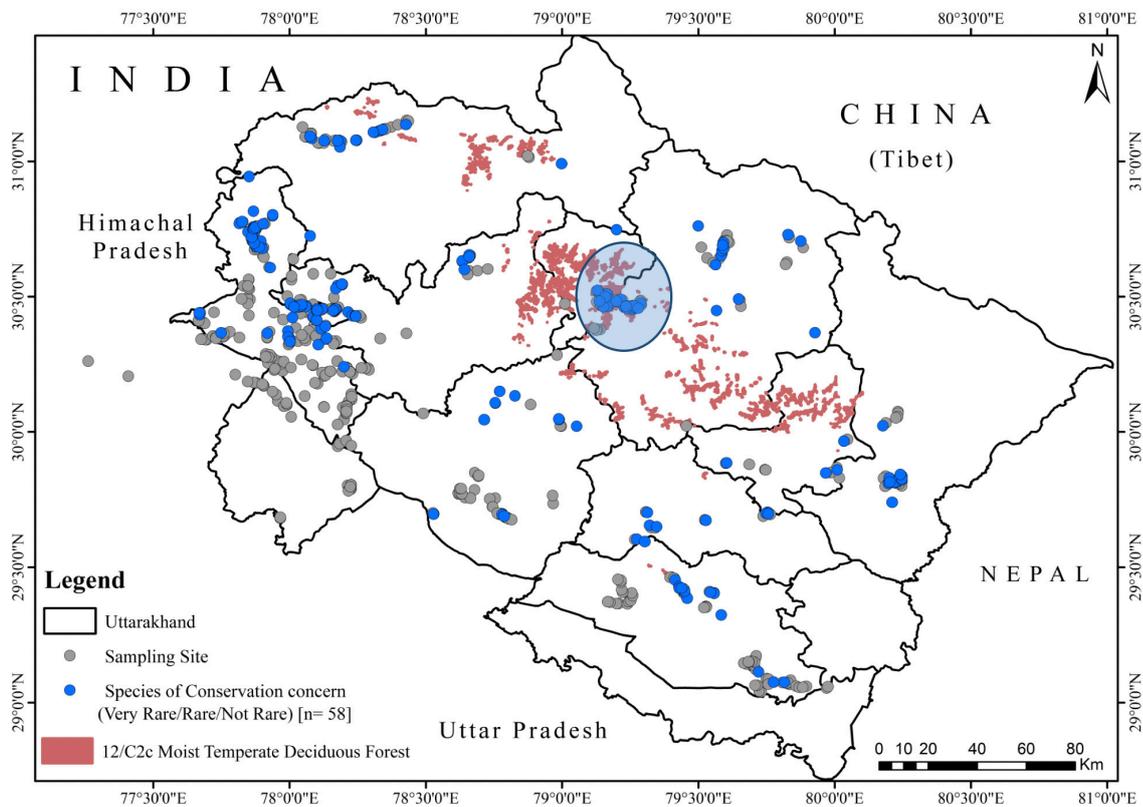


Figure 11. Important clusters of sites holding species of conservation priority in 12/C2c Moist Temperate Deciduous Forest in Uttarakhand.

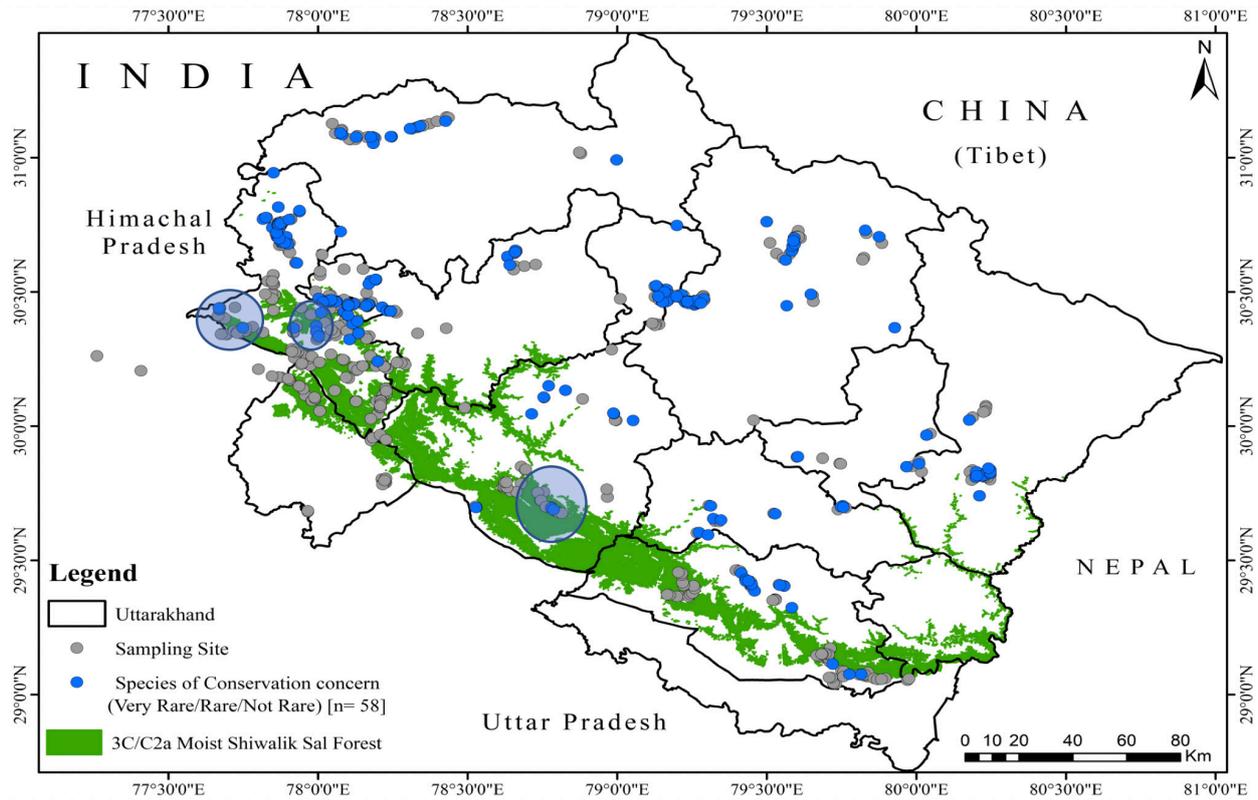


Figure 12. Important clusters of sites holding species of conservation priority in 3C/C2a Moist Shiwalik Sal Forest in Uttarakhand.

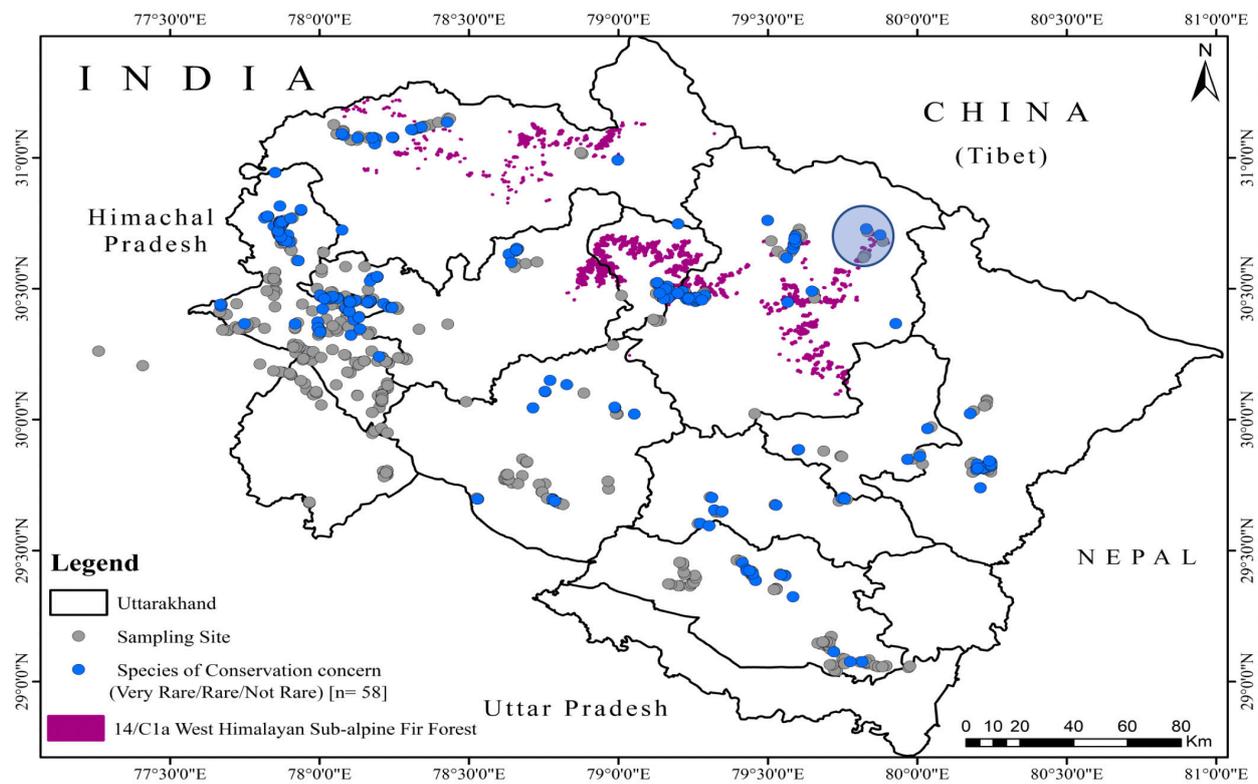


Figure 13. Important cluster of sites holding species of conservation priority in 14/C1a West Himalayan Sub-alpine Fir Forest in Uttarakhand.

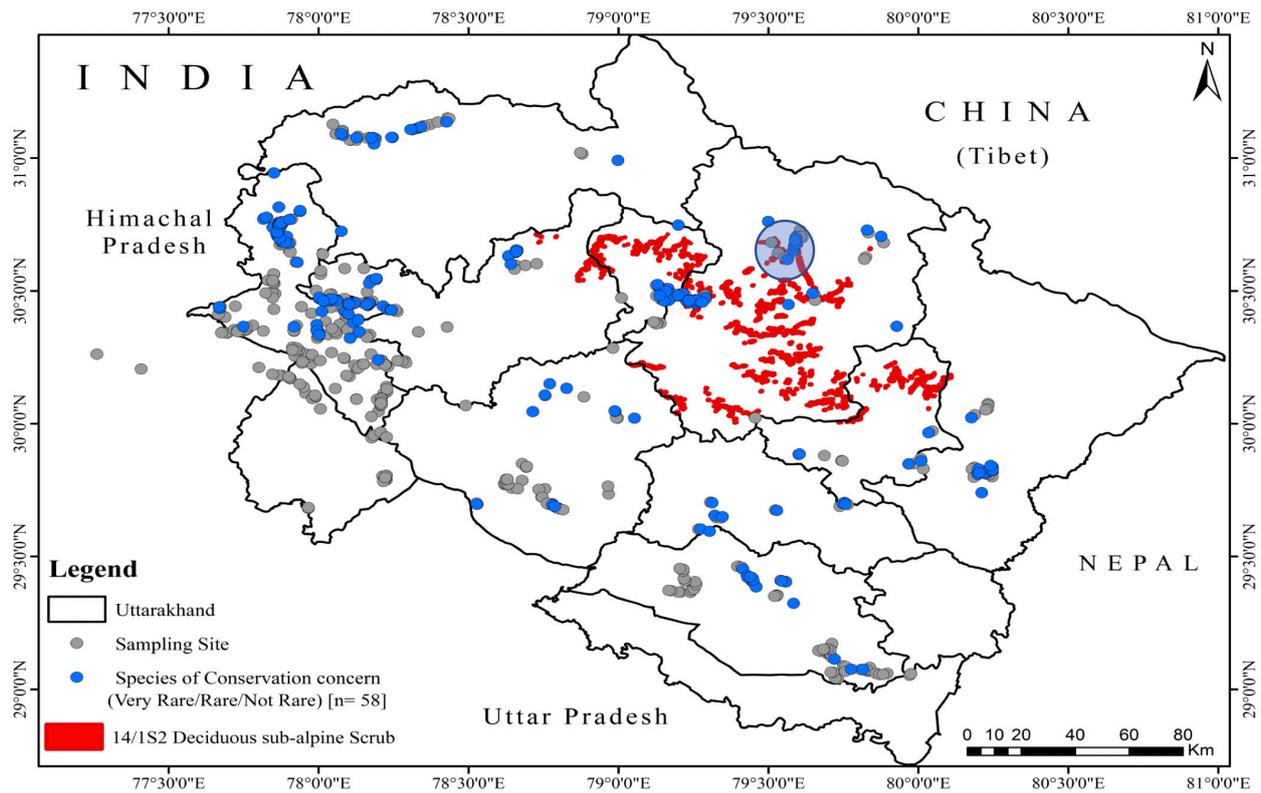


Figure 14. Important cluster of sites holding species of conservation priority in 14/1S2 Deciduous Sub-alpine Scrub in Uttarakhand.

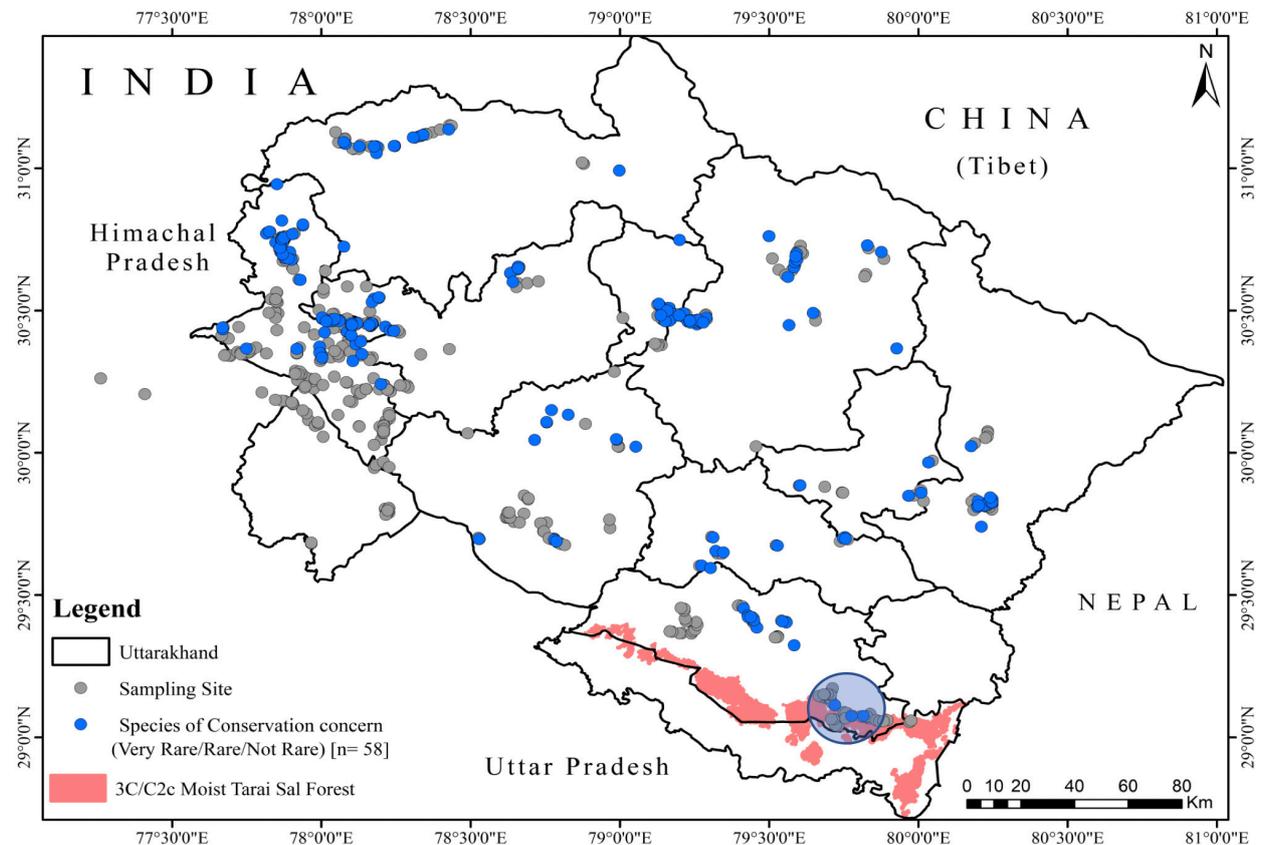


Figure 15. Important clusters of sites holding species of conservation priority in 3C/C2c Moist Terai Sal Forest in Uttarakhand.

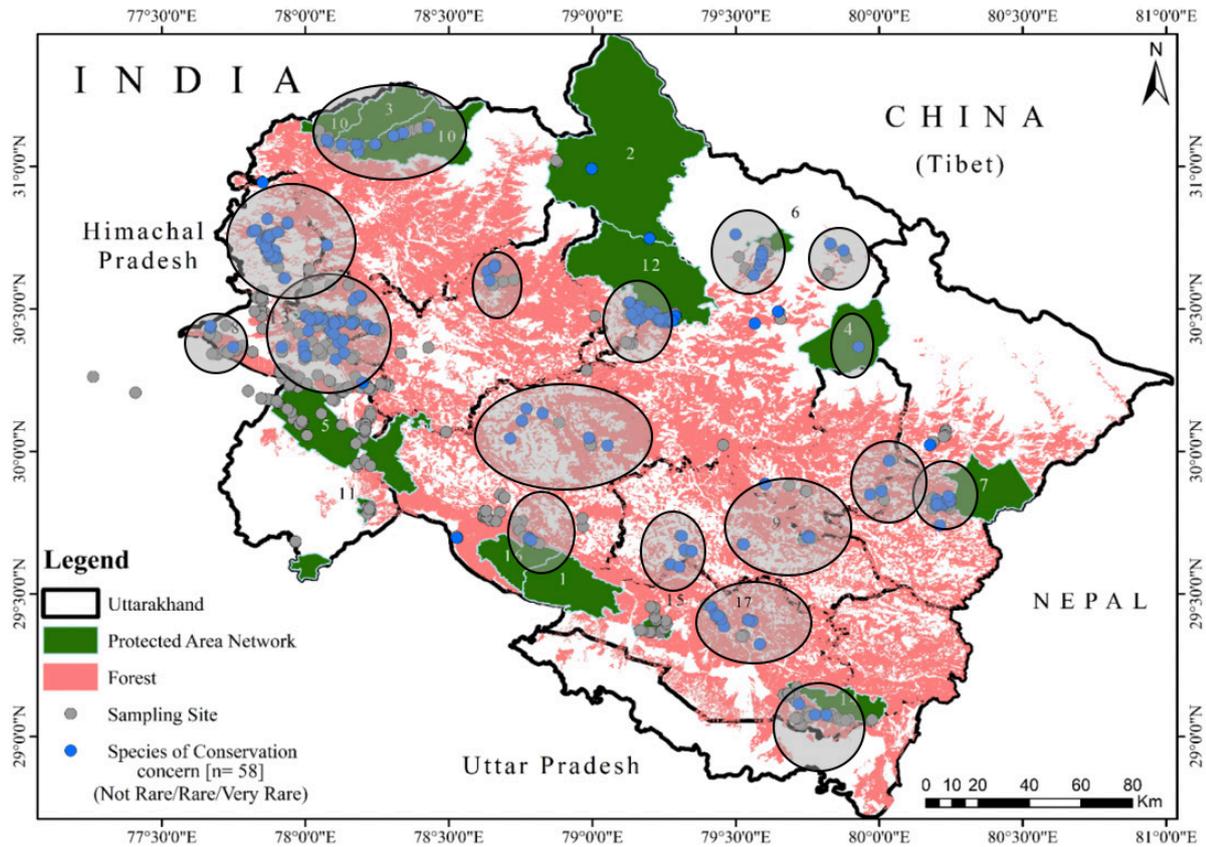


Figure 16. Locations of 58 butterfly species of conservation priority in relation to forest cover and the protected area network (16 no.), of Uttarakhand state along with 17 clusters where these species are concentrated.

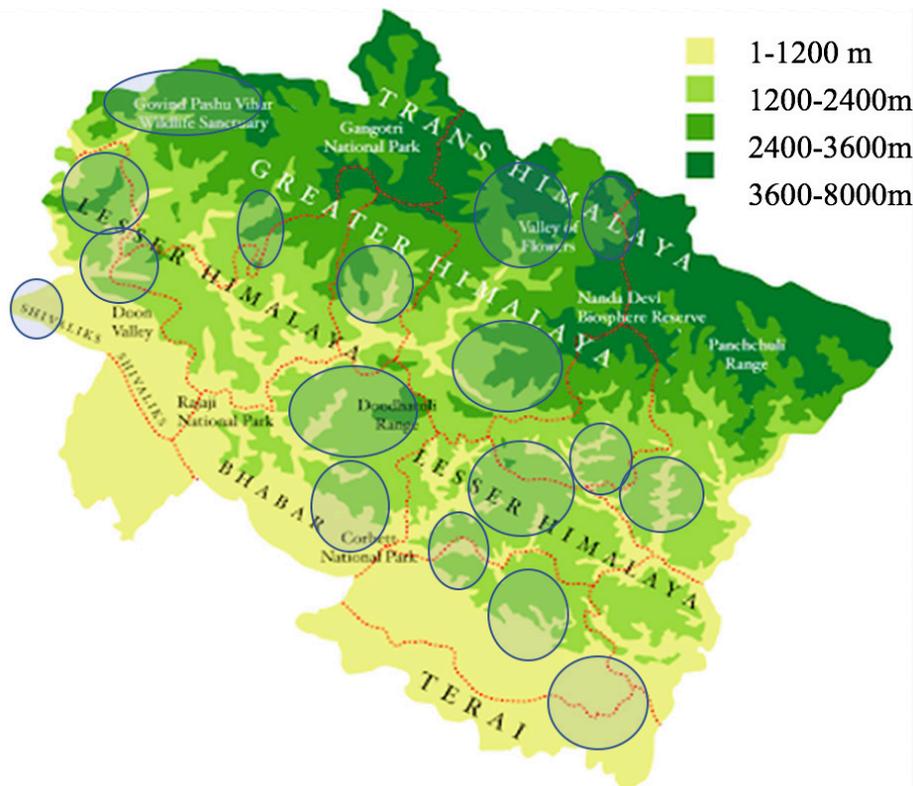


Figure 17. Locations of 17 clusters showing concentration of 58 butterfly species of conservation priority in relation to their altitudinal distribution in the state of Uttarakhand.

Sno	Name
1	Corbett National Park
2	Gangotri National Park
3	Govind National Park
4	Nanda Devi National Park
5	Rajaji National Park
6	Valley of Flowers National Park
7	Askot Wildlife Sanctuary
8	Asan Conservation Reserve
9	Binsar Wildlife Sanctuary
10	Govind Wildlife Sanctuary
11	Jhilmil Conservation Reserve
12	Kedarnath Wildlife Sanctuary
13	Benog/Mussoorie Wildlife Sanctuary
14	Nandhaur Wildlife Sanctuary
15	Pawalgarh Conservation Reserve
16	Sonanadi Wildlife Sanctuary
17	Naina Devi Bird Conservation Reserve

of 58 species of conservation priority are marked in 17 circles (Figure 16) and at least 12 of these occur outside the PA network based on the findings of the present study. Important forest sub-types identified falling in these clusters having species of conservation concern can thus be recommended for conservation or future PAs. Seventeen concentrations/clusters that are located in different physiographic zones represented in the state are, three in Trans Himalaya; three in Greater Himalaya; eight in Lesser Himalaya; one in Shivalik/Dun; one in Bhabar; and one in Tarai area along an elevation gradient, rather than a few as currently represented in the PA network of the state (Figure 17 & Appendix V).

Also, new conservation sites can be identified from these 17 clusters/concentrations of rare butterfly taxa especially in the 'Lesser Himalaya' where the number of PAs are almost negligible. This type of approach in identifying areas of conservation priority is more inclusive and suitable at a sub-regional or state level in restoring linkages and corridors in the PA network, rather than solely based on a broader geographic scale, i.e., zoogeographic zones. Many of these sites with high butterfly richness that lie outside the PAs and close to the villages and towns with suitable logistical support for boarding, lodging and travel can be promoted for sustainable and inclusive butterfly ecotourism activities in the state.

## REFERENCES

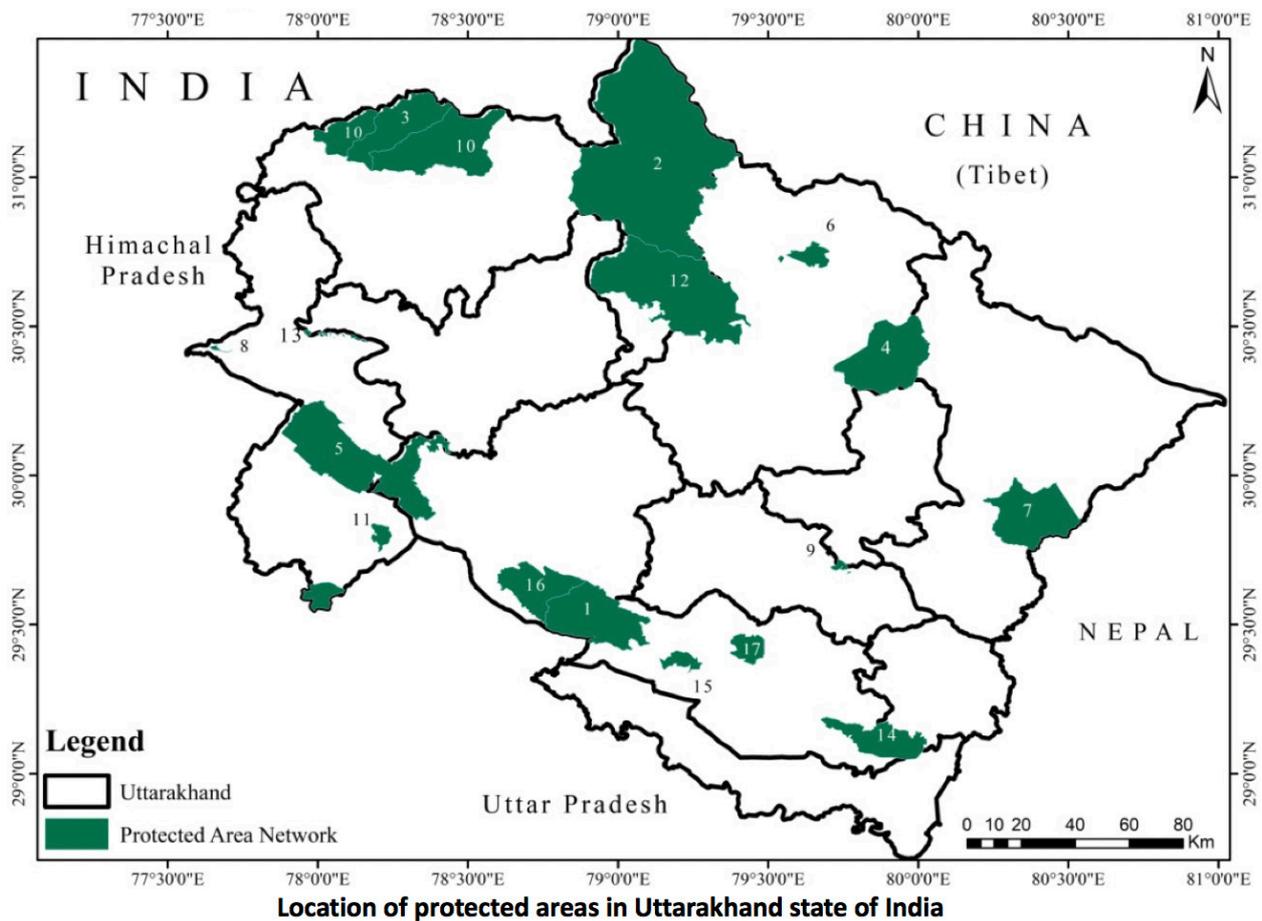
- Anonymous (2006).** *The Wildlife (Protection) Act 1972*. Natraj Publishers, Dehradun, 235 pp.
- Arita, H.T., J.G. Robinson & K.H. Redford (1990).** Rarity in Neotropical forest mammals and its ecological correlates. *Conservation Biology* 4(2): 181–192.
- Baindur, A. (1993).** The butterflies of Nanda Devi. In: *Scientific and Ecological Expedition Nanda Devi, 2nd May to 22nd July 1993*. (Army Corps of Engineers; W.I.I.; Salim Ali Centre for Ornithology & Natural History, WWF-India, G.B. Pant Institute of Himalayan Environment & Development, Botanical Survey of India) Army Headquarters, New Delhi, 35–43 pp.
- Bhardwaj, M., V.P. Uniyal, A.K. Sanyal & A.P. Singh (2012).** Butterfly communities along an elevation gradient in the Tons valley, Western Himalayas: Implications of rapid assessment of insect conservation. *Journal of Asia-Pacific Entomology* 15(1): 207–217.
- Bhardwaj, M. & V.P. Uniyal (2013).** High-altitude butterfly fauna of Gangotri National Park, Uttarakhand: Patterns in species abundance, composition and similarity, pp38–48. *ENVIS Bulletin on Wildlife and Protected Areas- Arthropods and their Conservation in India (Insects & Spiders)*, 232 pp.
- Berg, A. & M. Tjernberg (1996).** Common and rare Swedish vertebrates distribution and habitat preferences. *Biodiversity and Conservation* 5(1): 101–128.
- Bingham, C.T. (1905).** *Fauna of British India. Butterflies Vol. I*. Taylor and Francis, London, 511 pp.
- Botanical Survey of India (2021).** *Bibliography and Abstracts of Papers on Flora of Uttar Pradesh and Uttarakhand*. ENVIS, Government of India Ministry of Environment, Forest and Climate Change. Botanical Survey of India, Howrah, West Bengal, 616 pp.
- Brandis, D. (1906).** *Indian Trees: An Account of Trees, Shrubs, Woody Climbers, Bamboos, and Palms Indigenous or Commonly Cultivated in the British Indian Empire*. Archibald Constable and Co., Ltd. London, 767 pp.
- Brown, J.H. (1995).** *Macroecology*. University of Chicago Press, Chicago, IL, 284 pp.
- Brown, K.S. (1982).** Paleocology and regional patterns of evolution in neotropical forest butterflies, pp. 255–308. In: Prance, G.T. (ed). *Biological Diversification in the Tropics*. Columbia University Press, New York, 714 pp.
- Champion, H.G. & S.K. Seth (1968).** *A Revised Survey of The Forest Type of India*. Govt. of India Press. New Delhi, 404 pp.
- D'abrera, B. (1982).** *Butterflies of the Oriental Region - Part I. Papilionidae, Pieridae & Danaidae*. Hill House, Victoria, Australia, 244 pp.
- D'abrera, B. (1985).** *Butterflies of the Oriental Region - Part II. Nymphalidae, Satyridae & Amathusiidae*. Hill House, Victoria, Australia, 534 pp.
- D'abrera, B. (1986).** *Butterflies of the Oriental Region - Part III. Lycaenidae & Riodinidae*. Hill House, Victoria, Australia, 672 pp.
- Daniels, R.J.R., M. Hegde, N.V. Joshi & M. Gadgil (1991).** Assigning conservation value: a case study from India. *Conservation Biology* 5(4): 464–475.
- Doherty, W. (1886).** A list of butterflies in Kumaun. *Journal of the Asiatic Society of Bengal* 55(2): 103–140.
- Ehrlich, P.R. & P.H. Raven (1964).** Butterflies and plants: a study in co-evolution. *Evolution* 18: 586–608.
- Evans, W.H. (1932).** *The Identification of Indian Butterflies*. 2nd Edition. Bombay Natural History Society, Bombay, x+454 pp+32 pl.
- Forest Survey of India (2011).** *Atlas-Forest Types of India*. Forest Survey of India, Ministry of Environment and Forests, Govt. of India, Dehradun, 210 pp.
- Gaston, K.J. (1994).** *Rarity*. Chapman and Hall, London, 201 pp.
- Gaston, K.J. & T.M. Blackburn (1995).** Rarity and body size: some cautionary remarks. *Conservation Biology* 9(1): 210–213.
- Gilbert, L.E. & M.C. Singer (1975).** Butterfly Ecology. *Annual Review of Ecology and Systematics* 6(1): 365–397.
- Gilbert, L.E. & J.T. Smiley (1978).** Determinants of local diversity in

- phytophagous insects: host specialists in tropical environments, pp. 89–104. In: Mound, L.A. & N. Waloff (eds.). *Diversity of Insect Faunas*. Blackwell Scientific, 204 pp.
- Gilbert, L.E. (1980)**. Food web organization and the conservation of neotropical diversity, pp. 11–34. In: Soule, M.E. & B.A. Wilcox (eds.). *Conservation Biology: An Evolutionary-Ecological Perspective*. Sinauer Associates, Sunderland, Massachusetts, USA, 395 pp.
- Gilbert, L.E. (1984)**. The biology of butterfly communities, pp 41–54. In: Vane-Wright, R.I. & P.R. Ackery (eds.). *The Biology of Butterflies*. Princeton University Press, Princeton, New Jersey, USA, 429 pp.
- Gasse, P.V. (2017)**. *Annotated checklist of Butterflies of the Indo-Burmese region*. [http://flutters.org/home/docs/Butterflies\\_of\\_India\\_Paul\\_Van\\_Gasse.pdf](http://flutters.org/home/docs/Butterflies_of_India_Paul_Van_Gasse.pdf)
- Hannington, F. (1910–11)**. The butterflies of Kumaon. Parts I & Part II. *Journal of the Bombay Natural History Society* 20 (1): 130–142; (2): 361–372; (3): 871–872.
- Haribal, M. (1992)**. *Butterflies of Sikkim Himalaya and their Natural History*. Sikkim Nature Conservation Foundation, Gangtok, Sikkim, India, 217 pp.
- Khanduri, K., A. Singh, D. Singh, Kursotam & P. Garg (2013)**. Uttarakhand Himalayas: Hydropower Developments and its Impact on Environmental System. *Journal of Environment*. Volume 02. <https://www.researchgate.net/publication/264673061>.
- Kehimkar, I. (2008)**. *The Book of Indian Butterflies*. Bombay Natural History Society, Oxford University, Delhi Press, 497 pp.
- Kehimkar, I. (2016)**. *Butterflies of India*. Bombay Natural History Society, Mumbai, 505 pp.
- Kremen, C. (1992)**. Assessing the Indicator Properties of Species Assemblages for Natural Areas Monitoring. *Ecological Applications* 2(2): 203–217.
- Kremen, C., R.K. Colwell, T.L. Erwin, D.D. Murphy, R.F. Noss & M.A. Sanjayan (1993)**. Terrestrial arthropod assemblages: Their use in conservation planning. *Conservation Biology* 7(4): 796–808.
- Lomov, B., D.A. Keith, D.R. Britton & D.F. Hochuli (2006)**. Are butterflies and moths useful indicators for restoration monitoring? A pilot study in Sydney's Cumberland Plain Woodland 7(3): 204–210. <https://doi.org/10.1111/j.1442-8903.2006.00310.x>
- Mackinnon, P.W. & L. DeNicéville (1899)**. List of butterflies of Mussoorie in the Western Himalayas and neighbouring region. *Journal Bombay Natural History Society* 11(1): 205–221; (2): 368–389, 585–605.
- Moore, F. (1890–1897)**. *Lepidoptera indica*. Parts I-VII. Lovell Reeve Co.Ltd. London.
- Murphy, D.D. & B.A. Wilcox (1986)**. Butterfly diversity in natural habitat fragments: a test of the validity of vertebrate-based management, pp. 287–292. In: Verner, J., M.L. Morrison & C.J. Ralph (eds.). *Wildlife 2000, Modeling Habitat Relationships of Terrestrial Vertebrates*. University of Wisconsin Press, Madison, Wisconsin, USA, 699 pp.
- Murphy, D.D., K.E. Freas & S.B. Weiss (1990)**. An environment-metapopulation approach to population viability analysis for a threatened invertebrate. *Conservation Biology* 4(1): 41–51.
- Nayar, M.P. & A.R.K. Sastry (1987, 1988, 1990)**. *Red Data Book of Indian Plants* Vols. I, II, III. Botanical Survey of India, Calcutta.
- New, T.R. (1991)**. *Butterfly Conservation*. Oxford University Press, 224 pp.
- New, T.R., R.M. Pyle, J. A. Thomas, C.D. Thomas & P.C. Hammond (1995)**. Butterfly conservation management. *Annual Review of Entomology* 40 (1): 57–83.
- Ollenbach, O.C. (1930)**. Butterfly collection grounds at Mussoorie. *Journal of the Bombay Natural History Society* 34(3): 836–840.
- Pearman, P.B., M. Guerreiro, T.D. Sisk & D. Murphy (1995)**. Correlation patterns among groups proposed as biological indicators :what do they indicate. *Bulletin of the Ecological Society of America* 76: 375.
- Pimm, S.L., L.H. Jones & J. Diamond (1988)**. On the risk of extinction. *American Naturalist* 132(6): 757–785.
- Pollard, E. (1977)**. A method for assessing changes in the abundance of butterflies. *Biological Conservation* 12(2): 115–124.
- Pollard, E. & T.J. Yates (1993)**. *Monitoring Butterflies for Ecology and Conservation*. Chapman and Hall, London, 287 pp.
- Pyle, R.M. (1980)**. Butterfly eco-geography and biological conservation in Washington. *Atala* 8(1): 1–26.
- Primack, R. (1993)**. *Essentials of Conservation Biology*. Sinauer Associates, Sunderland, MA, 585 pp.
- Rabinowitz, D.S., S. Cairns & T. Dillon (1986)**. Seven forms of rarity and their frequency in flora of British Isles, pp. 182–204. In: Soule, M.E.(ed.). *Conservation Biology: the Science of scarcity and Diversity*. Sinauer, Sunderland, M.A, 584 pp.
- Rabinowitz, D.S. (1981)**. Seven forms of rarity, pp. 205–217. In: Synge, H. (ed.). *The Biological Aspects of Rare Plant Conservation*. Wiley, Chichester, U.K., 558 pp.
- Rai, I.D., G. Singh & G.S. Rawat (2017)**. *Plants of Kedarnath Wildlife Sanctuary, Western Himalaya: A Field Guide*. Bishen Singh Mahendra Pal Singh, Dehadun, 393 pp.
- Rodgers, W.A. & H.S Panwar (1988)**. Planning a Wildlife Protected Area Network in India. 2 vol. Project FO: IND/82/003, FAO, Dehradun 339, 267 pp.
- Rosenberg, D.M., H.V. Danks & D.M. Lehmkuhl(1986)**. Importance of insects in environmental impact assessment. Environment impact assessment. *Environment Management* 10(6): 773–783.
- Samways, M.J. (1994)**. Individual insect species and their conservation, pp. 169–193. In: *Insect Conservation Biology*. Chapman and Hall, London, 450 pp.
- Shull, E.M. (1958)**. My highest catch of butterfly species in a single day (4th June, 1957) Mussoorie, India. *Journal of the Lepidopterists' Society* 11(4–5): 167–168.
- Shull, E.M. (1962)**. Over one hundred butterfly species caught in a single day (3rd June, 1961) at Mussoorie, India. *Journal of the Lepidopterists' Society* 16: 143–145.
- Singh, A.P. (2017)**. Butterflies associated with major forest types in Arunachal Pradesh (Eastern Himalaya), India: Implications for eco-tourism and in conservation planning. *Journal of Threatened Taxa* 9(4): 10047–10075. <https://doi.org/10.11609/jott.2765.9.4.10047-10075>
- Singh, A.P. & R.S. Bhandari (2003)**. Butterfly diversity in tropical moist deciduous sal (*Shorea robusta*) forests of Dehradun valley: the lower western Himalayas. *Indian Forester* 129(10): 1257–1269.
- Singh, A.P. & R.S. Bhandari (2006)**. New Additions to the Butterflies of Dehradun valley, the lower Western Himalayas. *Indian Forester* 132(6): 767–769.
- Singh, A.P. & S. Sondhi (2016)**. Butterflies of Garhwal, Uttarakhand, western Himalaya, India. *Journal of Threatened Taxa* 8(4): 8666–8697. <https://doi.org/10.11609/jott.2254.8.4.8666-8697>
- Singh, A.P. (2016)**. Recent records of the Pale Jezebel *Delias sanaca sanaca* (Moore, 1857) (Lepidoptera: Pieridae) from Mussoorie hills, western Himalaya, India. *Journal of Threatened Taxa* 8(12): 9473–9478. <https://doi.org/10.11609/jott.2834.8.12.9473-9478>
- Singh, A.P. & S. Seal (2019)**. Occurrence of Dark Sapphire *Heliophorus indicus* Fruhstorfer, 1908 (Lepidoptera: Lycaenidae) in Garhwal Himalaya, Uttarakhand, India. *Bugs R All #175*, In: *Zoo's Print* 34 (7): 33–34.
- Singh, A.P. & T. Singh (2019)**. Recent records of the rare Mountain Tortoiseshell *Aglais rizana* (Moore, 1872) (Lepidoptera: Nymphalidae) in the upper Garhwal, western Himalaya, India, after 100 years. *Journal of Threatened Taxa* 11(15): 15068–15071. <https://doi.org/10.11609/jott.5276.11.15.15068-15071>
- Singh, A.P. & T. Singh (2020)**. Occurrence and association of the Scarce Lilacfork *Lethe dura gammiei* (Moore, [1892]) (Lepidoptera: Nymphalidae: Satyrinae) with Woolly-leaved Oak *Quercus lanata* Smith, 1819 (Fabaceae) forest in the Kumaon region of the Indian Himalaya. *Journal of Threatened Taxa* 12(3): 15387–15390. <https://doi.org/10.11609/jot.5467.12.3.15387-15390>
- Singh, A.P. & T. Singh (2021)**. Habitat association and hybridization in woodbrowns (*Lethe nicetas*, *L. sidonis* & *L. dakwania*) (Lepidoptera: Nymphalidae: Satyrinae) in Kedarnath Musk Deer Reserve, western Himalaya. *Journal of Threatened Taxa* 13(3): 18045–18049. <https://doi.org/10.11609/jott.6517.13.3.18045-18049>
- Singh, A.P. & T. Singh (2021)**. First record of White-ringed

- Meadowbrown, *Hyponphele davendra davendra* (Moore, 1865) (Lepidoptera: Nymphalidae) from inner valleys of Garhwal, Uttarakhand, India. *Journal of Bombay Natural History Society* 118(2): 1–5. <https://doi.org/10.17087/jbnhs/2021/v118/152490>
- Singh, A.P. & T. Singh (2022).** Occurrence of Dubious Five-Ring, *Ypthima parasakra* Eliot in Garhwal Himalaya. *Indian Journal of Entomology* 84(1): 1–3.
- Smetacek, P. (2002).** The genus *Pontia* Fabricius (Lepidoptera: Pieridae) in the Kumaon Himalaya. *Journal of the Bombay Natural History Society* 99(2): 224–231.
- Smetacek, P. (2004).** Descriptions of new Lepidoptera from the Kumaon Himalaya. *Journal of the Bombay Natural History Society* 101(2): 269–276.
- Smetacek, P. (2011).** Four new Lycaenid records from the Kumaon Himalaya. *Journal of Threatened Taxa* 3(2): 1555–1558. <https://doi.org/10.11609/JoTT.o2224.1555-8>
- Smetacek, P. (2012).** A new sub-species of *Mycalesis suaveolens* Wood-Mason & de Niceville 1883 from the western Himalaya, India (Lepidoptera, Nymphalidae, Satyrinae). *Nachrichten Entomologischen Vereins Apollo* 32: 105–108.
- Smetacek, P. (2012).** Butterflies (Lepidoptera: Papilionoidea and Hesperoidea) and other protected fauna of Jones Estate, a dying watershed in the Kumaon Himalaya, Uttarakhand, India. *Journal of Threatened Taxa* 4(9): 2857–2874. <https://doi.org/10.11609/JoTT.o3020.2857-74>
- Smith, C. (1989).** *Butterflies of Nepal (Central Himalaya)*. Tecpress Service L.P., Bangkok, 352 pp.
- Smith, C. (2006).** *Illustrated Checklist of Nepal Butterflies*. Craftman Press, Bangkok, 129 pp.
- Sondhi, S. (2017).** First records of butterflies *Anthene emolus emolus* (Godart, [1924]) (Lepidoptera: Lycaenidae: Polyommatainae) and *Gandaca harina assamica* Moore, [1906] (Lepidoptera: Pieridae: Coliadinae) from Kumaon, Uttarakhand, India. *Journal of Threatened Taxa* 9(6): 10355–10357. <https://doi.org/10.11609/jott.3233.9.6.10355-10357>
- Sondhi, S. & K. Kunte (2018).** *Butterflies of Uttarakhand- A Field Guide*. Bishen Singh Mahendra Pal Singh (Dehradun), Titli Trust (Dehradun) National Centre for Biological Sciences (Bengaluru).
- Swinhoe, C. (1905–1910).** *Lepidoptera Indica. Part VII. Rhopalocera–Papilionidae & Lycaenidae*. Lovell, Reeve & Co. Ltd, London, 286 pp + pls. 551–639.
- Swinhoe, C. (1910–1911).** *Lepidoptera Indica. Part VIII. Rhopalocera – Lycaenidae*. Lovell, Reeve & Co. Ltd., London, 293 pp + pls. 640–705.
- Swinhoe, C. (1911–1912).** *Lepidoptera Indica Part IX. Rhopalocera–Lycaenidae & Hesperiiidae*. Lovell, Reeve & Co. Ltd., London, 278 pp + pls. 706–756.
- Swinhoe, C. (1912–1913).** *Lepidoptera Indica. Part X. Rhopalocera – Hesperiiidae*. Lovell, Reeve & Co. Ltd., London, 364 pp + pls. 757–835.
- Talbot, G. (1939).** *The Fauna of British India including Ceylon and Burma*. Butterflies. 2nd edition. Vol. I. Taylor & Francis, London, 600 pp.
- Talbot, G. (1947).** *The Fauna of British India including Ceylon and Burma*. Butterflies. 2nd edition. Vol. II. Taylor & Francis, London, 506 pp.
- Thomas, J.A. (1983).** A quick method for estimating butterfly numbers during surveys. *Biological Conservation* 27(3): 195–211.
- Thomas, C.D. & H.C. Mallorie (1985).** Rarity, species richness and conservation: butterflies of the Atlas mountains in Morocco. *Biological Conservation* 33(2): 95–117.
- Vasudevan, K. & S. Sondhi (2010).** *Amphibians and Reptiles of Uttarakhand, India*. Wildlife Institute of India, 53 pp.
- Verma, A. & M.K. Arya (2018).** A preliminary study on the status and distribution of Butterfly Fauna in and around the valley of Reetha Sahib, Champawat, Kumaun Himalaya, India. *Biological Forum- An International Journal* 10(1): 43–51.
- Wells, S.M., M.R. Pyle & M. Collins (1983).** *The IUCN invertebrate Red Data Book*. IUCN, Switzerland, 623 pp.
- Wynter-Blyth, M.A. (1957).** *Butterflies of the Indian Region*. Bombay Natural History Society, Bombay, xx+523 pp+72 pls.

**Appendix I. List of protected areas in Uttarakhand state, India**

	Name	Area (km <sup>2</sup> )
1	Corbett National Park	520.82
2	Gangotri National Park	2390
3	Govind National Park	558.88
4	Nanda Devi National Park	624.6
5	Rajaji National Park	819.54
6	Valley of Flowers National Park	87.50
7	Askot Wildlife Sanctuary	600
8	Asan Conservation Reserve	4.44
9	Binsar Wildlife Sanctuary	45.59
10	Govind Wildlife Sanctuary	481.05
11	Jhilmil Conservation Reserve	37.84
12	Kedarnath Wildlife Sanctuary	975.20
13	Benog/Mussoorie Wildlife Sanctuary	10.82
14	Nandhaur Wildlife Sanctuary	269.96
15	Pawalgarh Conservation Reserve	58.25
16	Sonanadi Wildlife Sanctuary	301.18
17	Naina Devi Bird Conservation Reserve	111.90



## Appendix II. Vegetation composition of forest sub-types sampled in the state taken up for study.

	Forest sub-type	Area (km <sup>2</sup> )	Percent of state cover	Dominant trees
1	3C/C2a Moist Shiwalik Sal Forest	3158	12.97	<i>Shorea robusta</i> , <i>Anogeissus latifolia</i> , <i>Terminalia tomentosa</i> , <i>T.bellerica</i> , <i>Adina cordifolia</i> , <i>Lannea coromandelica</i> , <i>Mallotus philippensis</i>
2	3C/C2c Moist Terai Sal Forest	542	2.19	<i>Shorea robusta</i> , <i>Adina cordifolia</i> , <i>T.alata</i> , <i>Terwia nudiflora</i> , <i>Syzygium cumini</i> , <i>Litsea glutinosa</i> , <i>Lagerstroemia parviflora</i> , <i>Cordia dichotoma</i> , <i>Putranjiva roxburghii</i> , <i>Litsea monopetla</i> , <i>Pogostemon benghalensis</i> .
3	5B/C1a Dry Shiwalik Sal Forest	236	1.5	<i>Shorea robusta</i> , <i>Anogeissus latifolia</i> , <i>Buchanania lanzan</i> , <i>Terminalia tomentosa</i> , <i>Bauhinia variegata</i> , <i>Emblica officinalis</i> , <i>Acacia catechu</i> , <i>Pinus roxburghii</i> , <i>Schleichera oleosa</i> , <i>Cassia fistula</i> , <i>Zizyphus xylopyrus</i> (B. vahlii-shrub)
4	5B/C2 Northern Dry Mixed Deciduous Forest	678	2.82	<i>Anogeissus latifolia</i> , <i>Boswellia serrata</i> , <i>Acacia catechu</i> , <i>Shorea robusta</i> , <i>Bauhinia spp.</i> , <i>Bauchanania lanzan</i> , <i>Diospyros tomentosa</i> , <i>Terminalia bellerica</i> , <i>Kydiacalycina</i> , <i>Sterculia lappes</i> , <i>Miytragyna parvifolia</i> , <i>Aegle marmelos</i> , <i>Butea monsperma</i> , <i>Flacourtia indica</i> , <i>Zizyphus mauratina</i>
5	5/1S2 Khair-Sissu Forest	236	0.98	<i>Dalbergia sissoo</i> , <i>Acacia catechu</i> , <i>Zyzyphus mauritiana</i> , <i>Ehretia laevis</i> , <i>Holoptelea integrifolia</i> .
6	9/C1b Upper or Himalayan Chir Pine Forest	6278	26.07	<i>Pinus roxburghii</i> , <i>Quercus leucotrichophora</i> ; <i>Lyonia ovalifolia</i> , <i>Rhododendron arboreum</i> , <i>Pyrus pashia</i> , <i>Myrica esculanta</i> , <i>Pyraecantha crenulata</i> , <i>Symplocos crataegoides</i> .
7	12/C1a Ban Oak Forest	4798	20.23	<i>Quercus leucotrichophora</i> , <i>Rhododendron arboreum</i> , <i>Lyonia ovalifolia</i> , <i>Rhus semialata</i> , <i>Symplocos crataegoides</i> , <i>Benthamedia capitata</i> , <i>Carpinus viminea</i> , <i>Betula alnoides</i>
8	12/C1b Moru Oak Forest	9317	3.95	<i>Quercus floribunda</i> , <i>Q.leucotrichophora</i> , <i>Pinus wallichiana</i> , <i>Betula alnoides</i> , <i>Carpinus viminea</i> , <i>Acer caesium</i> , <i>Michilus duthei</i> , <i>Aesculus indica</i> , <i>Abies pindrow</i> , <i>Picea smithiana</i> , <i>Juglans regia</i> .
9	12/C1c Moist Deodar Forest	485	1.96	<i>Cedrus deodara</i> , <i>Pinus wallichiana</i> , <i>Quercus leucotrichophora</i>
10	12/C1d Western Mixed Coniferous Forest- Spruce, Blue Pine, Silver Fir	513	2.19	<i>Picea smithiana</i> , <i>Cedrus deodara</i> , <i>Abies pindrow</i> , <i>Pinus wallichiana</i> , <i>Quercus floribunda</i> , <i>Q.semecarpifolia</i> , <i>Q.leucotrichophora</i> , <i>Acer caesium</i> , <i>A.pictum</i> , <i>A. acuminatum</i> , <i>Eunonymus lacerus</i> , <i>Taxus baccata</i> , <i>Betula alnoides</i> .
11	12/C1e Moist Temperate Deciduous Forest	246	1.07	<i>Alnus nepalensis</i> , <i>Aesculus indica</i> , <i>Acer caesium</i> , <i>A.pictum</i> , <i>Carpinus viminea</i> , <i>Ulmus wallichiana</i> , <i>Betula alnoides</i> , <i>Juglans regia</i> , <i>Fraxinus micrantha</i> , <i>Quercus leucotrichophora</i> , <i>Q.floribunda</i> , <i>Q.semecarpifolia</i> , <i>Prunus cornuta</i> , <i>Rhododendron arboreum</i> .
12	12/C2a Kharsu Oak Forest ( <i>Q. semecarpifolia</i> )	227	0.99	<i>Quercus semecarpifolia</i> , <i>Abiespindrow</i> , <i>Betula alnoides</i> , <i>Q. floribunda</i> , <i>Acer caesium</i> , <i>Ilex dipyrena</i> , <i>Taxus baccata</i> .
13	12/C2b West Himalayan Upper Oak/Fir Forest	1087	4.57	<i>Abiespindrow</i> , <i>Piceasmithiana</i> , <i>Quercus semecarpifolia</i> , <i>Q.floribunda</i> , <i>Pyrus lanata</i> , <i>Acer caesium</i> , <i>Meliosma dilleniaefolia</i> , <i>Eunonymus lacerus</i> , <i>Ilex dipyrena</i> , <i>Sorbussoliosa</i> , <i>Rhododendron arboreum</i> , <i>R. barbatum</i> , <i>Ulmus wallichiana</i> , <i>Aesc ulus indica</i> , <i>Corylus colurna</i>
14	12/2S1 Low Level Blue Pine Forest	384	1.54	<i>Pinus wallichiana</i> , <i>Quercus leucotrichophora</i>
15	13/C2b Dry Deodar Forest	363	1.46	<i>Cedrus deodara</i> , <i>Pinus wallichiana</i> , <i>Picea smithiana</i> , <i>Corylus colurna</i>
16	14/C1a West Himalayan Sub-Alpine High Level Fir Forest	195	0.78	<i>Abies spectalilis</i> , <i>Pinus wallichiana</i> , <i>Piceasmithiana</i> , <i>Rhododendron companulatum</i> , <i>Taxus baccata</i> , <i>Prunus padus</i>
17	14/C1b West Himalayan Sub-Alpine Birch/ Fir Forest	583	2.47	<i>Abies spectabilis</i> , <i>Acer cappadocicum</i> , <i>Betula utilis</i> , <i>Quercus semecarpifolia</i> , <i>Rhododendron campanulatum</i> , <i>R. anthopogon</i> , <i>Lyonia ovalifolia</i> , <i>Sorbusfoliolosa</i>
18	14/1S2 Deciduous Sub-Alpine Scrub	200	0.86	<i>Betula utilis</i>
19	15/C1 Birch/Rhododendron Scrub Forest	136	0.56	<i>Betula utilis</i> , <i>Rhododendron companulatum</i> , <i>Sorbus foliolosa</i> , <i>Quercus semecarpifolia</i>
20	15/E1 Dwarf Rhododendron Scrub	32	0.13	<i>Rhododendron anthopogon</i> , <i>R. lepidotum</i> , <i>R. companulatum</i> , <i>Ilex dipyrena</i>

Source: Champion &amp; Seth (1968).

**Appendix III. Complete list of butterflies sampled in 20 different forest types of Uttarakhand ranked according to their relative abundances (2006–2009 & 2017–2020).**

	Butterfly species
A.	<b>Very Common</b>
1	<i>Eurema hecabe</i> (Linnaeus, 1758)
2	<i>Catopsilia pomona</i> (Fabricius, 1775)
3	<i>Ypthima sakra sakra</i> Moore, [1858]
4	<i>Pieris canidia indica</i> Evans, 1926
5	<i>Celastrina huegeli huegeli</i> (Moore, 1882)
6	<i>Aporia agathon</i> (Gray, 1831)
7	<i>Junonia iphita iphita</i> (Cramer, [1779])
8	<i>Callerebia nirmala</i> (Moore, 1865)
9	<i>Aglais caschmirensis aesis</i> (Fruhstorfer, 1912)
10	<i>Papilio polytes romulus</i> Cramer, [1775]
11	<i>Pseudozizeeria maha maha</i> (Kollar, [1844])
12	<i>Acytolepis puspa</i> (Horsfield, [1828])
13	<i>Aulocera swaha swaha</i> (Kollar, [1844])
14	<i>Dodona durga durga</i> (Kollar, [1844])
15	<i>Leptosia nina</i> (Fabricius, 1793)
16	<i>Neptis hylas varmona</i> Moore, 1872
17	<i>Vanessa indica indica</i> (Herbst, 1794)
18	<i>Euploea core core</i> (Cramer, [1780])
19	<i>Arhopala amantes apella</i> (Swinhoe, 1886)
20	<i>Pieris brassicae</i> (Linnaeus, 1758)
21	<i>Neptis mahendra mahendra</i> Moore, 1872
22	<i>Gonepteryx rhamni nepalensis</i> Doubleday, 1847
23	<i>Vanessa cardui</i> (Linnaeus, 1758)
24	<i>Celastrina lavendularis limbatus</i> (Moore, 1879)
25	<i>Ypthima huebneri</i> Kirby, 1871
26	<i>Junonia lemonias lemonias</i> (Linnaeus, 1758)
27	<i>Lethe sidonis</i> (Hewitson, 1863)
28	<i>Ariadne merione tapestrina</i> (Moore, 1884)
29	<i>Lasiommata schakra schakra</i> (Kollar, [1844])
30	<i>Symbrenthia lilaea khasiana</i> Moore, [1875]
31	<i>Phalanta phalantha phalantha</i> (Drury, [1773])
32	<i>Callerebia hybrida</i> Butler, 1880
33	<i>Arhopala atrax</i> (Hewitson, 1862)
34	<i>Callerebia scanda scanda</i> (Kollar, [1844])
35	<i>Parantica aglea melanoides</i> Moore, 1883
36	<i>Athyma opalina opalina</i> Kollar, 1844
37	<i>Heliophorus sena</i> (Kollar, [1844])
38	<i>Prosotas nora ardates</i> (Moore, [1875])
39	<i>Catopsilia pyranthe</i> (Linnaeus, 1758)
40	<i>Colias fieldii</i> Ménétériés, 1855
41	<i>Ypthima nikaea</i> Moore, [1875]
42	<i>Cepora nerissa phryne</i> (Fabricius, 1775)

	Butterfly species
43	<i>Danaus chrysippus chrysippus</i> (Linnaeus, 1758)
44	<i>Lethe verma verma</i> (Kollar, [1844])
45	<i>Ypthima inica</i> Hewitson, [1865]
46	<i>Ypthima baldus baldus</i> (Fabricius, 1775)
47	<i>Pareronia hippia</i> (Fabricius, 1787)
48	<i>Castalius rosimon rosimon</i> (Fabricius, 1775)
49	<i>Heliophorus tamu tamu</i> (Kollar, [1844])
50	<i>Acraea issoria issoria</i> (Hübner, [1819])
51	<i>Lampides boeticus</i> (Linnaeus, 1767)
52	<i>Cyrestis thyodamas ganescha</i> Kollar, 1848
53	<i>Jamides celeno celeno</i> (Cramer, [1775])
54	<i>Delias belladonna horsfieldi</i> (Gray, 1831)
55	<i>Neopithecops zalmora zalmora</i> (Butler, [1870])
56	<i>Euploea mulciber mulciber</i> (Cramer, [1777])
57	<i>Euaspa milionia milionia</i> (Hewitson, [1869])
58	<i>Sephisa dichroa</i> (Kollar, [1844])
59	<i>Issoria issaea</i> (Doherty, 1886)
60	<i>Prosotas dubiosa indica</i> (Evans, [1925])
61	<i>Junonia atlites atlites</i> (Linnaeus, 1763)
62	<i>Callerebia annada caeca</i> (Watkins, 1925)
63	<i>Ypthima nareda</i> (Kollar, [1844])
64	<i>Danaus genutia genutia</i> (Cramer, [1779])
65	<i>Papilio demoleus demoleus</i> Linnaeus, 1758
66	<i>Mycalesis perseus blasius</i> Fabricius, 1798
67	<i>Arhopala ganesa ganesa</i> (Moore, [1858])
68	<i>Colias erate</i> (Esper, 1805)
69	<i>Eurema blanda</i> (Boisduval, 1836)
70	<i>Junonia hierta hierta</i> (Fabricius, 1798)
71	<i>Parantica sita sita</i> (Kollar, [1844])
72	<i>Zizeeria karsandra</i> (Moore, 1865)
73	<i>Cupha erymanthis lotis</i> (Sulzer, 1776)
74	<i>Athyma perius perius</i> (Linnaeus, 1758)
75	<i>Kaniska canace canace</i> (Linnaeus, 1763)
76	<i>Ixias pyrene</i> (Linnaeus, 1764)
77	<i>Zizina otis otis</i> (Fabricius, 1787)
78	<i>Hypolimnas bolina jacintha</i> (Drury, 1773)
79	<i>Chrysozephyrus birupa</i> Moore, 1877
80	<i>Acraea terpsicore</i> (Linnaeus, 1758)
81	<i>Lycaena phlaeas baralacha</i> (Moore, 1884)
82	<i>Delias eucharis</i> (Drury, 1773)
83	<i>Celaenorrhinus leucocera</i> (Kollar, [1844])
84	<i>Junonia almana almana</i> (Linnaeus, 1758)
85	<i>Junonia orithya</i> (Linnaeus, 1758)

	Butterfly species
86	<i>Pelopidas mathias mathias</i> (Fabricius, 1798)
87	<i>Melanitis leda leda</i> (Linnaeus, 1758)
88	<i>Charaxes bhārata</i> C. & R. Felder, [1867]
89	<i>Argynnis childreni sakontala</i> Kollar, [1848]
90	<i>Esakiozephyrus icana icana</i> (Moore, [1875])
91	<i>Libythea lepita lepita</i> Moore, [1858]
<b>B.</b>	<b>Common</b>
92	<i>Euthalia patala patala</i> (Kollar, [1844])
93	<i>Pantoporia hordonia hordonia</i> (Stoll, [1790])
94	<i>Orinoma damaris damaris</i> Gray, 1846
95	<i>Tanaecia lepidea lepidea</i> (Butler, 1868)
96	<i>Chilades pandava pandava</i> (Horsfield, [1829])
97	<i>Papilio protenor protenor</i> Cramer, [1775]
98	<i>Lycaena panava</i> (Westwood, 1852)
99	<i>Talicauda nyseus nyseus</i> (Guérin-Méneville, 1843)
100	<i>Oriens gola pseudolus</i> (Mabille, 1883)
101	<i>Dodona dipoea nostia</i> Fruhstorfer, 1912
102	<i>Modusa procris</i> (Cramer, [1777])
103	<i>Rapala manea schistacea</i> (Moore, 1879)
104	<i>Pseudocoladenia fatih</i> (Kollar, [1844])
105	<i>Byasa polyeuctes letincius</i> (Fruhstorfer, 1908)
106	<i>Elymnias hypermnestra undularis</i> (Drury, 1773)
107	<i>Euthalia lubentina lubentina</i> (Cramer, [1777])
108	<i>Zemeros flegyas flegyas</i> (Cramer, [1780])
109	<i>Rhaphicera moorei moorei</i> (Butler, 1867)
110	<i>Callerebia hyagriva hyagriva</i> (Moore, [1858])
111	<i>Hypolycaena othana othana</i> Hewitson, [1865]
112	<i>Dodona eugenus</i> Bates, [1868]
113	<i>Sarangesa dasahara</i> (Moore, [1866])
114	<i>Eurema brigitta rubella</i> (Wallace, 1867)
115	<i>Mycalis mineus mineus</i> (Linnaeus, 1758)
116	<i>Abisara bifasciata suffusa</i> Moore, 1882
117	<i>Euthalia aconthea garuda</i> (Moore, [1858])
118	<i>Rapala varuna orseis</i> (Hewitson, [1863])
119	<i>Graphium cloanthus cloanthus</i> (Westwood, 1841)
120	<i>Curetis acuta dentata</i> Moore, 1879
121	<i>Heliophorus moorei coruscans</i> (Moore, 1882)
122	<i>Notocrypta curvifascia curvifascia</i> (C. & R. Felder, 1862)
123	<i>Eurema laeta laeta</i> (Boisduval, 1836)
124	<i>Celatoxia marginata marginata</i> (de Nicéville, [1884])
125	<i>Papilio bianor polyctor</i> Boisduval, 1836
126	<i>Lethe confusa confusa</i> Aurivillius, [1898]
127	<i>Lethe dura gammiei</i> (Moore, [1892])
128	<i>Kallima inachus inachus</i> (Doyère, [1840])
129	<i>Catochrysops strabo strabo</i> (Fabricius, 1793)

	Butterfly species
130	<i>Aporia leucodice</i> (Eversmann, 1843)
131	<i>Polytremis eltola eltola</i> (Hewitson, 1869)
132	<i>Symbrenthia hypselis cotanda</i> Moore, [1875]
133	<i>Megisba malaya sikkima</i> Moore, 1884
134	<i>Neptis ananta ananta</i> Moore, [1858]
135	<i>Graphium nomius nomius</i> (Esper, 1799)
136	<i>Belenois aurota aurota</i> (Fabricius, 1793)
137	<i>Pseudergeris wedah wedah</i> (Kollar, [1844])
138	<i>Arhopala dodonaea</i> (Moore, [1858])
139	<i>Chilades lajus lajus</i> (Stoll, [1780])
140	<i>Poritia hewitsoni hewitsoni</i> Moore, [1866]
141	<i>Pieris melete ajaka</i> Moore, 1865
142	<i>Lethe isana isana</i> (Kollar, [1844])
143	<i>Leptotes plinius plinius</i> (Fabricius, 1793)
144	<i>Neptis sankara sankara</i> (Kollar, [1844])
145	<i>Rapala nissa nissa</i> (Kollar, [1844])
146	<i>Byasa latreillei latreillei</i> (Donovan, 1826)
147	<i>Lethe nicetas</i> (Hewitson, 1863)
148	<i>Tirumala septentrionis septentrionis</i> (Butler, 1874)
149	<i>Parnara guttatus mangala</i> (Moore, [1866])
150	<i>Eurema andersonii jordani</i> Corbet & Pendlebury, 1932
151	<i>Stibochiona nicea nicea</i> (Gray, 1846)
152	<i>Auzakia danava danava</i> (Moore, [1858])
153	<i>Celaenorrhinus patula</i> de Nicéville, 1889
154	<i>Pelopidas assamensis</i> (de Nicéville, 1882)
155	<i>Symphaedra nais</i> (Forster, 1771)
156	<i>Abisara fylla</i> (Westwood, [1851])
157	<i>Graphium sarpedon sarpedon</i> (Linnaeus, 1758)
158	<i>Troides aeacus</i> (C. & R. Felder, 1860)
159	<i>Hestinalis nama nama</i> (Doubleday, 1844)
160	<i>Neptis nata yerburii</i> Butler, 1886
161	<i>Vagrans egista sinha</i> (Kollar, [1844])
162	<i>Heliophorus oda</i> (Hewitson, 1865)
163	<i>Oriens goloides</i> (Moore, [1881])
164	<i>Argynnis hyperbius hyperbius</i> (Linnaeus, 1763)
165	<i>Tirumala limniace exoticus</i> (Gmélin, 1790)
166	<i>Udara albocaeruleus albocaeruleus</i> (Moore, 1879)
167	<i>Zizula hylax hylax</i> (Fabricius, 1775)
168	<i>Matapa aria</i> (Moore, [1866])
169	<i>Pachliopta aristolochiae aristolochiae</i> (Fabricius, 1775)
170	<i>Athyma selenophora selenophora</i> (Kollar, [1844])
171	<i>Lethe europa niladana</i> Fruhstorfer, 1911
172	<i>Libythea myrrha sanguinalis</i> Fruhstorfer, 1898
173	<i>Ypthima asterape mahratta</i> Moore, 1884
174	<i>Tarucus indica</i> Evans, 1932

	Butterfly species
175	<i>Udara dilectus dilectus</i> (Moore, 1879)
176	<i>Borbo cinnara</i> (Wallace, 1866)
177	<i>Pelopidas subochracea</i> (Moore, 1878)
178	<i>Ixias marianne</i> (Cramer, [1779])
179	<i>Argynnis kamala</i> Moore, [1858]
180	<i>Telinga heri</i> (Moore, [1858])
181	<i>Taractrocera danna</i> (Moore, 1865)
182	<i>Telicota bambusae bambusae</i> (Moore, 1878)
183	<i>Chrysozephyrus syla</i> Kollar, 1848
184	<i>Lobocla liliana ignatius</i> (Plötz, 1882)
185	<i>Pelopidas sinensis</i> (Mabille, 1877)
<b>C.</b>	<b>Fairly Common (Median)</b>
186	<i>Delias sanaca sanaca</i> (Moore, [1858])
187	<i>Pontia daplidice moorei</i> (Röber, [1907])
188	<i>Lethe rohria rohria</i> (Fabricius, 1787)
189	<i>Tagiades litigiosa litigiosa</i> Möschler, 1878
190	<i>Aulocera saraswati saraswati</i> (Kollar, [1844])
191	<i>Mycalesis visala visala</i> Moore, [1858]
192	<i>Neptis melba melba</i> Evans, 1912
193	<i>Symbrenthia brabira brabira</i> Moore, 1872
194	<i>Everes argiades diporides</i> Chapman, 1908
195	<i>Jamides bochus bochus</i> (Stoll, [1782])
196	<i>Tarucus nara</i> (Kollar, 1848)
197	<i>Papilio machaon</i> Linnaeus, 1758
198	<i>Hypolimnas misippus</i> (Linnaeus, 1764)
199	<i>Spialia galba galba</i> (Fabricius, 1793)
200	<i>Papilio clytia clytia</i> Linnaeus, 1758
201	<i>Melanitis phedima bela</i> Moore, [1858]
202	<i>Tarucus venosus</i> Moore, 1882
203	<i>Athyma cama cama</i> Moore, [1858]
204	<i>Celastrina gigas</i> (Hemming, 1928)
205	<i>Byasa dasarada ravana</i> (Moore, [1858])
206	<i>Neptis sappho astola</i> Moore, 1872
207	<i>Loxura atymnus continentalis</i> Fruhstorfer, [1912]
208	<i>Oreolyce vardhana vardhana</i> (Moore, [1875])
209	<i>Shizuyaozephyrus ziha</i> (Hewitson, [1865])
210	<i>Surendra quercetorum quercetorum</i> (Moore, [1858])
211	<i>Graphium agamemnon agamemnon</i> (Linnaeus, 1758)
212	<i>Neope yama buckleyi</i> Talbot, 1947
213	<i>Neptis clinia praedicta</i> Smetacek, 2011
214	<i>Phaedyma columella ophiana</i> (Moore, 1872)
215	<i>Everes lacturnus assamica</i> Tytler, 1915
216	<i>Horaga onyx onyx</i> (Moore, [1858])
217	<i>Atrophaneura varuna astorion</i> (Westwood, 1842)
218	<i>Euripus consimilis consimilis</i> (Westwood, [1851])

	Butterfly species
219	<i>Neope pulaha pandyia</i> (Talbot, 1947)
220	<i>Telinga lepcha lepcha</i> (Moore, 1880)
221	<i>Arhopala rama rama</i> (Kollar, [1844])
222	<i>Euchrysops cnejus cnejus</i> (Fabricius, 1798)
223	<i>Spindasis vulcanus vulcanus</i> (Fabricius, 1775)
224	<i>Notocrypta feisthamelii alysos</i> (Moore, [1866])
225	<i>Telicota colon colon</i> (Fabricius, 1775)
226	<i>Parnassius hardwickei</i> Gray, 1831
227	<i>Neptis cartica cartica</i> Moore, 1872
228	<i>Rapala iarbus sorya</i> (Kollar, [1844])
229	<i>Papilio paris paris</i> Linnaeus, 1758
230	<i>Athyma asura asura</i> Moore, [1858]
231	<i>Aricia agestis nazira</i> (Moore, [1866])
232	<i>Deudorix epijarbas epijarbas</i> (Moore, [1858])
233	<i>Rapala selira</i> (Moore, 1874)
234	<i>Burara jaina jaina</i> (Moore, [1866])
235	<i>Iambrix salsala salsala</i> (Moore, [1866])
236	<i>Meandrusa lachinus lachinus</i> (Fruhstorfer, 1902)
237	<i>Papilio agestor govindra</i> Moore, 1864
238	<i>Charaxes bernardus hierax</i> C. & R. Felder, [1867]
239	<i>Mycalesis francisca sanātana</i> Moore, [1858]
240	<i>Neptis soma butleri</i> Eliot, 1969
241	<i>Neptis zaida zaida</i> Doubleday, [1848]
242	<i>Hypolycaena kina kina</i> Hewitson, [1869]
243	<i>Borbo bevani</i> (Moore, 1878)
244	<i>Sarangesa purendra purendra</i> Moore, 1882
245	<i>Graphium euroas caschmirensis</i> (Rothschild, 1895)
246	<i>Hestina persimilis zella</i> Butler, 1869
247	<i>Paralasa kalinda kalinda</i> Moore, 1865
248	<i>Polygania c-album cognata</i> Moore, [1899]
249	<i>Telinga nicotia</i> (Westwood, [1850])
250	<i>Freyeria trochylus orientalis</i> Forster, 1980
251	<i>Pratapa icetas icetas</i> (Hewitson, [1865])
252	<i>Caprona agama agama</i> (Moore, [1858])
253	<i>Celaenorrhinus munda</i> (Moore, 1884)
254	<i>Celaenorrhinus pulomaya pulomaya</i> (Moore, [1866])
255	<i>Suastus gremius gremius</i> (Fabricius, 1798)
256	<i>Udaspes folus</i> (Cramer, [1775])
257	<i>Ypthima kedarnathensis</i> Singh, 2007
258	<i>Heliophorus brahma brahma</i> (Moore, [1858])
259	<i>Ampittia dioscorides dioscorides</i> (Fabricius, 1793)
260	<i>Burara oedipodea belesis</i> (Mabille, 1876)
261	<i>Sovia lucasii</i> (Mabille, 1876)
262	<i>Polytremis discreta discreta</i> (Elwes & Edwards, 1897)
263	<i>Papilio arcturus arius</i> Rothschild, 1908

	Butterfly species
264	<i>Dilipa morgiana</i> (Westwood, [1851])
265	<i>Nymphalis xanthomelas fervescens</i> (Stichel, [1908])
266	<i>Celastrina argiolus kollari</i> (Westwood, [1852])
267	<i>Spindasis ictis ictis</i> (Hewitson, 1865)
268	<i>Zesius chrysomallus</i> Hübner, [1819]
269	<i>Caprona ransonnettii potiphora</i> (Hewitson, 1873)
270	<i>Potanthus dara</i> (Kollar, [1844])
271	<i>Tagiades menaka menaka</i> (Moore, [1866])
272	<i>Tarucus callinara</i> (Butler, 1886)
273	<i>Anthene emolus emolus</i> (Godart, [1824])
<b>D.</b>	<b>Uncommon</b>
274	<i>Aulocera brahminus</i> (Blanchard, 1853)
275	<i>Symbrenthia niphanda hysudra</i> Moore, 1874
276	<i>Freyeria putli</i> (Kollar, [1844])
277	<i>Iraota timoleon timoleon</i> (Stoll, [1790])
278	<i>Tajuria cippus cippus</i> (Fabricius, 1798)
279	<i>Tajuria diaeus diaeus</i> (Hewitson, [1865])
280	<i>Choaspes benjaminii japonica</i> (Murray, 1875)
281	<i>Hyarotis adrastus praba</i> (Moore, [1866])
282	<i>Pelopidas conjuncta conjuncta</i> (Herrich-Schäffer, 1869)
283	<i>Graphium doson axionides</i> (Page & Treadaway, 2014)
284	<i>Aporia agathon phryxe</i> (Boisduval, 1836)
285	<i>Charaxes dolon dolon</i> Westwood, [1848]
286	<i>Mimathyma ambica ambica</i> (Kollar, [1844])
287	<i>Ypthima indecora</i> Moore, 1882
288	<i>Ancema ctesia ctesia</i> (Hewitson, [1865])
289	<i>Chaetoprocta odata peilei</i> Forster, 1980
290	<i>Curetis bulis bulis</i> (Westwood, [1851])
291	<i>Thermozephyrus ataxus ataxus</i> (Westwood, [1851])
292	<i>Virachola perse perse</i> (Hewitson, [1863])
293	<i>Aeromachus stigmata stigmata</i> (Moore, 1878)
294	<i>Celaenorrhinus dhanada</i> (Moore, [1866])
295	<i>Tagiades japedus ravi</i> (Moore, [1866])
296	<i>Gandaca harina assamica</i> Moore, 1906
297	<i>Neptis narayana</i> Moore, 1858
298	<i>Ypthima hanningtoni hanningtoni</i> Eliot, 1967
299	<i>Arhopala paraganesa paraganesa</i> (de Nicéville, 1882)
300	<i>Azanas ubaldus</i> (Stoll, [1782])
301	<i>Aeromachus dubius</i> Elwes & Edwards, 1897
302	<i>Badamia exclamations</i> (Fabricius, 1775)
303	<i>Argynnis jainadeva jainadeva</i> Moore, 1864
304	<i>Aulocera padma padma</i> (Kollar, [1844])
305	<i>Lethe baladeva aisa</i> Fruhstorfer, 1911
306	<i>Lethe sinorix sinorix</i> (Hewitson, [1863])
307	<i>Spindasis nipalicus</i> (Moore, 1884)

	Butterfly species
308	<i>Baoris farri</i> (Moore, 1878)
309	<i>Bibasis sena sena</i> (Moore, [1866])
310	<i>Atrophaneura aidoneus</i> (Doubleday, 1845)
311	<i>Graphium garhwalia</i> (Katayama, 1988)
312	<i>Aporia agathon caphusa</i> (Moore, 1872)
313	<i>Gonepteryx mahaguru mahaguru</i> Gistel, 1857
314	<i>Ariadne ariadne pallidior</i> (Fruhstorfer, 1899)
315	<i>Charaxes solon solon</i> (Fabricius, 1793)
316	<i>Pantoporia sandaka davidsoni</i> Eliot, 1969
317	<i>Tanaecia julii appiades</i> (Ménétriés, 1857)
318	<i>Ypthima avanta</i> Moore, [1875]
319	<i>Flos asoka</i> (de Nicéville, [1884])
320	<i>Petrelaea dana</i> (de Nicéville, [1884])
321	<i>Rapala pheretima petosiris</i> (Hewitson, [1863])
322	<i>Sinthus chandrana chandrana</i> (Moore, 1882)
323	<i>Spalgis epius epius</i> (Westwood, [1851])
324	<i>Virachola isocrates</i> (Fabricius, 1793)
325	<i>Dodona ouida phlegra</i> Fruhstorfer, 1914
326	<i>Celaenorrhinus pero pero</i> de Nicéville, 1889
327	<i>Coladenia indrani indrani</i> (Moore, [1866])
328	<i>Ochlodes brahma</i> (Moore, 1878)
329	<i>Odontoptilum angulata angulata</i> (C. Felder, 1862)
330	<i>Seseria dohertyi dohertyi</i> (Watson, 1893)
331	<i>Taractrocera maevius</i> (Fabricius, 1793)
332	<i>Papilio alcmenor alcmenor</i> C. & R. Felder, [1864]
333	<i>Papilio memnon agenor</i> Linnaeus, 1758
334	<i>Parnassius epaphus</i> Oberthür, 1879
335	<i>Appias lalage</i> (Doubleday, 1842)
336	<i>Appias libythea</i> (Fabricius, 1775)
337	<i>Aglais rizana</i> (Moore, 1872)
338	<i>Athyma inara inara</i> Westwood, 1850
339	<i>Euploea midamus</i> (Linnaeus, 1758)
340	<i>Hyponephele pulchella</i> (C. & R. Felder, [1867])
341	<i>Lethe dakwania</i> Tytler, 1939
342	<i>Mycalasis suaveolens ranotei</i> Smetacek, 2012
343	<i>Everes hugelii hugelii</i> (Gistel, 1857)
344	<i>Heliophorus indicus</i> (Fruhstorfer, 1908)
345	<i>Horaga viola</i> Moore, 1882
346	<i>Pratapa deva lila</i> Moore, [1884]
347	<i>Spindasis elima uniformis</i> (Moore, 1882)
348	<i>Tajuria jehana jehana</i> Moore, [1884]
349	<i>Baoris pagana</i> (de Nicéville, 1887)
350	<i>Caltoris kumara</i> (Moore, 1878)
351	<i>Erionota torus</i> Evans, 1941
352	<i>Pedesta masuriensis masuriensis</i> (Moore, 1878)

	Butterfly species
353	<i>Sovia grahami grahami</i> (Evans, 1926)
354	<i>Papilio bootes janaka</i> Moore, 1857
355	<i>Papilio helenus helenus</i> Linnaeus, 1758
356	<i>Parnassius charltonius</i> Gray, [1853]
357	<i>Colotis etrida</i> (Boisduval, 1836)
358	<i>Delias acalis pyramus</i> (Wallace, 1867)
359	<i>Charaxes agrarius</i> Swinhoe, [1887]
360	<i>Hyponephele davendra davendra</i> (Moore, 1865)
361	<i>Lethe goalpara goalpara</i> (Moore, [1866])
362	<i>Polygonia c-album agnicula</i> (Moore, 1872)
363	<i>Ypthima parasakra</i> Eliot, 1987

	Butterfly species
364	<i>Heliophorus epicles latilimbata</i> (Fruhstorfer, 1908)
365	<i>Miletus chinensis assamensis</i> (Doherty, 1891)
366	<i>Spindasis lohita himalayanus</i> (Moore, 1884)
367	<i>Hasora chromus</i> (Cramer, [1780])
368	<i>Thoressa aina</i> (de Nicéville, 1889)
369	<i>Maneca bhotea bhotea</i> (Moore, 1884)
370	<i>Celaenorrhinus pyrrha</i> de Nicéville, 1889

The relative abundance of butterfly taxa ranging from 1–1,596 individuals. The taxa are ranked into four abundance classes based on their quartile divisions, i.e., Q1= 1–7 Uncommon; Q2= 8–21= Fairly Common; Q3= 22–69= Common; Q4= 70–1,596= Very Common; Median value= 21.

#### Appendix IV. Butterfly taxa of conservation priority in Uttarakhand.

	Family/Scientific name	Common name	Distribution	Associated forest sub-type*	Abundance status	WPA status	Altitudinal distribution (m)
<b>A</b>	<b>PAPILLIONIDAE</b>						
1	<i>Byasa dasara daravana</i> (Moore, [1858])	Great Windmill	WH; CH	12C1a; 12/C1b	NR	NA	150–2750
2	<i>Graphium eurous caschmirensis</i> (Rothschild, 1895)	Six-bar Swordtail	WH; CH	12C1a	NR	NA	1000–2800
3	<i>Graphium garhwalica</i> (Katayama, 1988)	Garhwal Swordtail	WH	12C1a	R	NA	1600–2300
4	<i>Parnassius charltonius</i> Gray, [1853]	Regal Apollo	WH; PA	12C1a	R	NA	3600–4400
<b>B</b>	<b>PIERIDAE</b>						
5	<i>Aporia agathon caphusa</i> (Moore, 1872)	Garhwal Great Blackvein	WH; CH	14/C1a	NR	NA	1200–3050
6	<i>Aporia agathon phryxe</i> (Boisduval, 1836)	Kashmir Great Blackvein	WH	12C1a	NR	NA	Up to 2100
7	<i>Delias acalis pyramus</i> (Wallace, 1867)	Redbreast Jezebel	WH; CH	3C/C2a	NR	NA	Up to 1500
8	<i>Delias sanaca sanaca</i> (Moore, [1858])	Pale Jezebel	WH	12/C1a; 12/C1b	NR	Sch- I	1200–3000
9	<i>Gonepteryx mahaguru mahaguru</i> Gistel, 1857	Lesser Brimstone	WH; CH	12/C1a; 12/C2c	NR	NA	Above 2100
<b>C</b>	<b>NYMPHALIDAE</b>						
10	<i>Aglais rizana</i> (Moore, 1872)	Mountain Tortoiseshell	WH; EH	14/1S2	R	Sch-II	2400–4500
11	<i>Lethe dura gammiei</i> (Moore, [1892])	Scarce Lilacfork	WH; EH	12/C1a; 12/C2b	VR	Sch -I	1800–2200
12	<i>Polygonia c-album agnicula</i> (Moore, 1872)	Nepalese Comma	WH; CH; EH	14/C1a	R	Sch-II	2200–4500
13	<i>Ypthima parasakra parasakra</i> Eliot, 1987	Dubious Five-ring	WH; CH; EH	12/2S1	R	NA	2000–2700
14	<i>Argynnis jainadeva jainadeva</i> Moore, 1864	HighbrownSilverspot	WH; CH	14/C1a	NR	NA	2400–4700
15	<i>Callerebia hyagriva hyagriva</i> (Moore, [1858])	Brown Argus	WH	9/C1b	R	Sch-II	1500–2400
16	<i>Callerebia scanda scanda</i> (Kollar, [1844])	Pallid Argus	WH	12/C1a; 12/C1b; 12/C1d	NR	NA	1200–2800
17	<i>Charaxes dolon dolon</i> Westwood, [1848]	Stately Nawab	WH; CH	12/C1a; 9/C1b	R	Sch -II	1430–1900
18	<i>Euthalia patala patala</i> (Kollar, [1844])	Grand Duchess	WH	12/C1a	NR	NA	400–2500
19	<i>Hestina persimilis zella</i> Butler, 1869	Siren	WH	12/C1a; 3C/C2a	R	Sch -II	750–1460

	Family/Scientific name	Common name	Distribution	Associated forest sub-type*	Abundance status	WPA status	Altitudinal distribution (m)
20	<i>Hyponphele davendra davendra</i> (Moore, 1865)	White-ringed Meadowbrown	WH; PA	12/C1c	R	Sch-II	900–2400
21	<i>Hyponphele lepulchella</i> (C. & R. Felder, [1867])	Tawny Meadowbrown	WH; PA	12/C2b	NR	NA	3000–3600
22	<i>Lethe baladeva aisa</i> Fruhstorfer, 1911	Treble Silverstripe	WH; CH	12/C1a; 12/C2c	R	Sch-II	1800–2200
23	<i>Lethe dakwania</i> Tytler, 1939	White-wedged Woodbrown	WH	12/C2c	R	NA	2300–3900
24	<i>Lethe goalpara goalpara</i> (Moore, [1866])	Large Goldenfork	WH; CH	12/C2c	R	Sch-II	1800–3000
25	<i>Lethe isana isana</i> (Kollar, [1844])	Common Forester	WH	12/C1a; 12/C1d; 9/C1b	R	NA	1500–2700
26	<i>Mycalesis suaveolens ranotei</i> Smetacek, 2012	Wood-Mason's Bushbrown	WH; CH	12/C1a	R	Sch-II	1700–2133
27	<i>Neope pulaha pandyia</i> (Talbot, 1947)	Veined Labyrinth	WH	12/C1a; 12/C2c; 12/2S1	R	Sch-II	1500–3050
28	<i>Neope yama buckleyi</i> Talbot, 1947	Dusky Labyrinth	WH; CH	12/C1a; 12/C2c	NR	Sch-II	1200–2370
29	<i>Neptis anantaananta</i> Moore, [1858]	Yellow Sailer	WH	12/C1a; 12/C2c	R	NA	400–2300
30	<i>Neptis clinia praedicta</i> Smetacek, 2011	Sullied Sailer	WH	3C/C2a; 3C/C2c; 12/C1a	NR	NA	Low
31	<i>Neptis sankara sankara</i> (Kollar, [1844])	Broad-banded Sailer	WH	3C/C2a; 5B/C2; 12/C1a	NR	NA	800–2500
32	<i>Neptis Zaida Zaida</i> Doubleday, [1848]	Pale Green Sailer	WH; CH	3C/C2a; 12/C1a	R	Sch-II	900–2500
33	<i>Nymphalis xanthomelas fervescens</i> (Stichel, [1908])	Large Tortoiseshell	WH; CH	12/C1a; 12/C2b; 14/C1a	NR	NA	900–3200
34	<i>Paralasa kalinda kalinda</i> Moore, 1865	Scarce Mountain Argus	WH	3C/C2a; 3C/C2c; 12/C1a	R	NA	2700–3900
35	<i>Polygonia c-album cognata</i> Moore, [1899]	Kumaon Comma	WH	12/C1a; 12/C2c	NR	NA	2100–4800
36	<i>Sephis dichroa</i> (Kollar, [1844])	Western Courtier	WH; CH	12/C1a; 12/C1b; 12/C2c	NR	NA	1500–2740
37	<i>Symbrenthia niphanda hysudra</i> Moore, 1874	Bluetail Jester	WH; CH	12/C1a; 12/C2c	R	Sch-II	1000–2600
38	<i>Telinga Lepcha lepcha</i> (Moore, 1880)	West Himalayan Lepcha Bushbrown	WH; CH	12/C1a; 12/C2c; 3C/C2a	NR	NA	1100–2400
39	<i>Ypthima avanta</i> Moore, [1875]	Jewel Five-ring	WH; CH	12/C1a	NR	NA	600–1800
40	<i>Ypthima hannyingtoni hannyingtoni</i> Eliot, 1967	Garhwal Large Branded Five-ring	WH; CH	12/C1a; 12/C1b	NR	NA	2100–2300
41	<i>Ypthima indecora</i> Moore, 1882	Western Five-ring	WH; CH	12/C1a; 12/C2c	NR	NA	1300–1700
42	<i>Ypthima kedarnathensis</i> Singh, 2007	Garhwal Six-ring	WH; CH	12/C1a; 12/C2c	R	NA	1600–2200
<b>D.</b>	<b>LYCAENIDAE</b>						
43	<i>Aricia agestis nazira</i> (Moore, [1866])	Orange-bordered Argus	WH; CH	12/C1a	NR	NA	1800–2980
44	<i>Chrysozephyrus birupa</i> Moore, 1877	Fawn Hairstreak	WH; CH	12/C1a; 12/C2c	NR	NA	above 1400
45	<i>Esakiozephyrus icana icana</i> (Moore, [1875])	Dull-green Hairstreak	WH; CH	12/C1a; 12/C1d	R	Sch-II	2000–3300
46	<i>Euaspa milionia milionia</i> (Hewitson, [1869])	Water Hairstreak	WH; CH	12/C1a	NR	NA	1200–2000
47	<i>Heliophorus moorei coruscans</i> (Moore, 1882)	Azure Sapphire	WH; CH	12/C1a; 12/C2c	R	NA	1300–3000
48	<i>Pratapa icetas icetas</i> (Hewitson, [1865])	Dark Blue Royal	WH; CH	12/C1a; 12/C2b; 12/C2c	R	Sch-II	1500–2700
49	<i>Shizuyaozephyrus ziha</i> (Hewitson, [1865])	White-spotted Hairstreak	WH; CH	12/C1a	R	Sch-II	1200–2000
50	<i>Sinthusia chandrana chandrana</i> (Moore, 1882)	Broad Spark	WH; CH	12/C1a; 12/C1d; 3C/C2a	R	Sch-II	Up to 1820

	Family/Scientific name	Common name	Distribution	Associated forest sub-type*	Abundance status	WPA status	Altitudinal distribution (m)
51	<i>Spindasis elimauni formis</i> (Moore, 1882)	Scarce Shot Silverline	WH; CH	3C/C2a	NR	Sch-II	Up to 2700
52	<i>Thermozephyrus ataxus ataxus</i> (Westwood, [1851])	Wonderful Hairstreak	WH; CH	12/C1a; 12/C2c	R	NA	1800–2400
<b>E</b>	<b>RIODINIDAE</b>						
53	<i>Dodona dipoea nostia</i> Fruhstorfer, 1912	Lesser Punch	WH	12/C1a; 12/C2c	R	Sch-II	1800–3000
54	<i>Dodona ovida phlegra</i> Fruhstorfer, 1914	Mixed Punch	WH; CH	12/C1a; 12/C2c	NR	NA	1200–2400
<b>F</b>	<b>HESPERIIDAE</b>						
55	<i>Celaenorrhinus peropero</i> deNicéville, 1889	Mussoorie Spotted Flat	WH	12/C1a	R	NA	1500–2000
56	<i>Potanthus dara</i> (Kollar, [1844])	Himalayan Dart	WH; CH	12/C1a; 3C/C2a	NR	NA	1830–2590
57	<i>Sovia lucasii</i> (Mabille, 1876)	Lucas's Ace	WH; EH	9/C1b	R	NA	1800–2000
58	<i>Thoressa aina</i> (de Nicéville, 1889)	Garhwal Ace	WH; CH	12/C1a	R	NA	1370–2800

WH–Western Himlaya | CH–Central Himalaya | \* Forest Sub-type reference Table 2 | Abundance Status (Evans 1932): VR–Very Rare | R–Rare | NR–Not Rare | WPA–Wildlife (Protection) Act 1972 (Anonymous 2006) | Sch–Schedule listed in WPA1972 (Anon 2006).

**Appendix V. Locations of Western Himalayan forest sub-types identified holding butterfly species of conservation priority in the state of Uttarakhand spread over different physiographic zones along the elevation gradient.**

	Physiographic zone	Forest Sub-type	District	Site/village/Reserve Forest
A.	Trans Himalaya (Above 3600m)	14/C1a WestHimalayan Sub-alpine Fir Forest	Chamoli	Ghamsali-Niti Pass
		14/1S2 Deciduous Sub-alpine Scrub	Chamoli	Mana-Badrinath & Valley of Flowers NP.
B.	Greater Himalaya (2400–3600m)	12/C1a Ban Oak Forest	Chamoli & Rudraprayag	Mandal-Chopta-Duggalbitta-Makkumath-Kedarnath WS
			Uttarkashi dist	Naitwar-Sankri-Taluka-Osla (Govind WS)
			Tehri Garhwal	Buddha Kedar-Jhala
		12/C2c Moist Temperate Deciduous Forest	Chamoli & Rudra prayag	Mandal-Chopta/Makkumath-Duggalbitta
C.	Lesser Himalaya (1200-2400m)	12/C1a Ban Oak Forest	Dehradun & Tehri Garhwal	BenogWS-Mussoorie-Kotikimoi-Rotu-ki-beli
			Dehradun	Chakrata Cantt-Deoban-Mundali (Chakrata Forest Division)
			Pauri	Pauri-Talisain-Dudatoli ridge
			Pithoragarh	Didihat-Thal
			Nainital	Naina Devi Conservation reserve-Kilbury-Pangot-Vinayak Khal
			Almora	Ranikhet Binsar WS
D.	Shiwalik-Dun/Bhabar (Below 1200m)	3C/C2a Moist Shiwalik Sal Forest	Dehradun	Timli RF-Karvapani RF Jhajra RF, Chowki Dhaulas-Rikhoul RF
			Pauri	Rahuthua dhab-Mundipani-Nauri
E.	Tarai (100–350m)	3C/C2c Moist Terai Sal Forest	Nainital	Chorgalia-Jolasal-Senapani (Nandhaur WS)





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