

# **Assessment of Vegetation in Kibber Wildlife Sanctuary, Distt. Lahaul Spiti, Himachal Pradesh**

## **PROJECT COMPLETION REPORT**

**Submitted to**  
**Himachal Pradesh Forest Department (Wildlife)**



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**2020**

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- 4. Date of Commencement of the Project** : 21-09- 2016
- 5. Date of Completion of Project** : 20-09-2019
- 6. Duration of the Project** : Three years
- 7. Total Outlay Sanctioned** : Rs. 21,81,000
- 8. Total grant released till 20/09/19** : Rs. 12,63,000
- 9. Grant released during the first year** : Rs. 7,63,000
- 10. Grant released during the second year** : Rs. 5,00,000
- 11. Total expenditure incurred during the entire period of the project** : Rs. 10,96,970

## 12. Introduction

Biodiversity usually refer to variety within a living organism and the broad usage of the system embraces many different parameters. It is required now to collect, collate, relate and document the existing natural wealth for the benefit of living organism (Tewari & Kapoor, 2013). Biological diversity has great significance for every living being and also in maintaining ecological balance on Earth. Anthropogenic activities influence the vegetation adversely. In the world, it has 36 biodiversity hotspots based on criteria of exceptional concentration of endemic plants and higher degree of anthropogenic pressure. These mega biodiversity hotspots have more than half of all endemic plant and terrestrial vertebrate species and probably similar proportions of less well known mega diverse groups like invertebrates and fungi, are only found in these 36 global biodiversity hotspots which collectively comprised around 2.5 percent Earth's land surface (Myers *et al.*, 2000; Noss *et al.*, 2015; Stork and Habel, 2014 and Habel *et al.*, 2019). Maximum area of these hotspots come under the tropical areas of the world and supports two-third population of the world (Veech, 2003). Now these days biodiversity hotspots are facing many challenges because of anthropogenic pressure and impact of climatic variability.

India has four global biodiversity hotspots i.e. The Himalayas, The Western Ghats, Indo-Burma and Sundaland (Chitale *et al.*, 2015). India is a treasure of biodiversity and is one of the eight important “*Vavilorian*” centre of origin and crop diversity (Anil *et al.*, 2014). India has 8 % of total global biodiversity with an estimated 49000 species of plants and having 4900 endemic species (Anil *et al.*, 2014). About 17000 species of flowering plants have been reported in India and other plants taxa include 5000 species of algae, 20000 fungi, 2700 bryophytes, 1600 lichens and 600 pteridophytes (Agrawal, 1998).

Himalaya being the one of the youngest mountains chain in the world comprises about 10% of the total land surface of India. Due to different climatic conditions, altitude and size it comprises characteristics that are unique to this region only. Endowed with a large range of natural variety and floristic composition, it has a large number of floral and faunal species including about 9000 species of angiosperms and 3470 species, considered endemic to Himalaya, thus categorized it as one of the hotspot of biodiversity (Verma and Kapoor, 2010).

Cold desert mean an area where the climate has characteristic and great extremes of hot and cold combined with excessive dryness. Temperature in the cold desert generally varies from -45°C during winter to 40°C in summers and rainfall is below 60 mm. The pH ranges generally from 7.4 to 9.4 (Tewari & Kapoor, 2013).

The vegetation has resemblance to flora from Afganistan, Tibet, Siberia and the Himalayan region and the dominant families include Asteraceae, Brassicaceae, Boraginaceae, Leguminosae, Carophyllaceae, Chenopodiaceae, Labiatae, Rosaceae, Scrophulariaceae, Chenopodiaceae, Rannunculaceae and Gentianaceae (Negi, 1995). Three vegetation types in India are found in the cold desert i.e. 15/C3- Alpine pastures, 16/C1- Dry alpine scrub and 16/E1- Dwarf juniper scrub.

The cold desert in India mainly comprises Laddakh Union Territory, Lahaul and Spiti District and Pooh valley in Kinnaur district in Himachal Pradesh (Verma *et al.*, 2008). The low precipitation, huge variation in temperature in day and night, low fertility are some of the characteristics of the region. The growing season in the area is short due to its unique climatic condition and summer is only growing period for the plants (Kapoor, 2004). The vegetation in cold deserts shows a wide range of variation. It may extend from semi-desertic to desertic depending on the climate condition. The plants of cold desert are experiencing the pressure due to over exploitation for economical purposes by local people and other as well. The live stocks and migratory grazers are also responsible for degradation of fragile ecosystem due to overgrazing.

Once biodiversity is lost it cannot be reversed (Verma, *et al.* 2003). Significant losses of biodiversity could affect future of human life so biodiversity conservation has been practiced in India since time memorial. It is important to know the species present in any forest or ecosystem for sustainable use of biodiversity. The conservation of biodiversity is the need of the hour as well as practiced throughout the world since long time. Keeping these facts in views attempt has been made to observe the plants of Kibber WildLife sanctuary. The 16<sup>th</sup> Biosphere Reserve of India is cold desert including Kibber Wild Life Sanctuary and Pin Valley National Park (Srivastava, 2010 and Devi *et al.* 2013). Kibber Wildlife Sanctuary is situated in Spiti division of district Lahaul and Spiti in Himachal Pradesh. It lies between 32° 8' 49.082" to 32° 45'39.903" N latitudes and 77° 47' 59.726" to 78° 31' 29.452" E longitudes. The wildlife sanctuary is spreaded over 2220.12 km<sup>2</sup> which is bordered in the northern catchment of the spiti river and is enclosed by Ladakh in the north and Tibet in the east (Kala, 2005). The sanctuary has three beats i.e. Kibber, Langza and Lalung. The area (Km<sup>2</sup>) of Kibber, Langza and Lalung beat is 1124.50, 752 and 343 .62 Km<sup>2</sup>, respectively. The wildlife sanctuary is located at an altitude that varies from 3700-6700 m above mean sea level (Devi *et al.*, 2013 and Green, 1993).

### **13. Objectives of the Project**

#### **Short-term Objectives**

1. To study floristic diversity and phyto-sociology of vegetation.
2. To identify plant diversity rich areas.
3. To identify threatened or abundant plant species in the sanctuary.
4. To study physico-chemical properties of soil.

#### **Long-term objective:**

To know and conserve the plant wealth of the sanctuary.

### **14. Review of Literature**

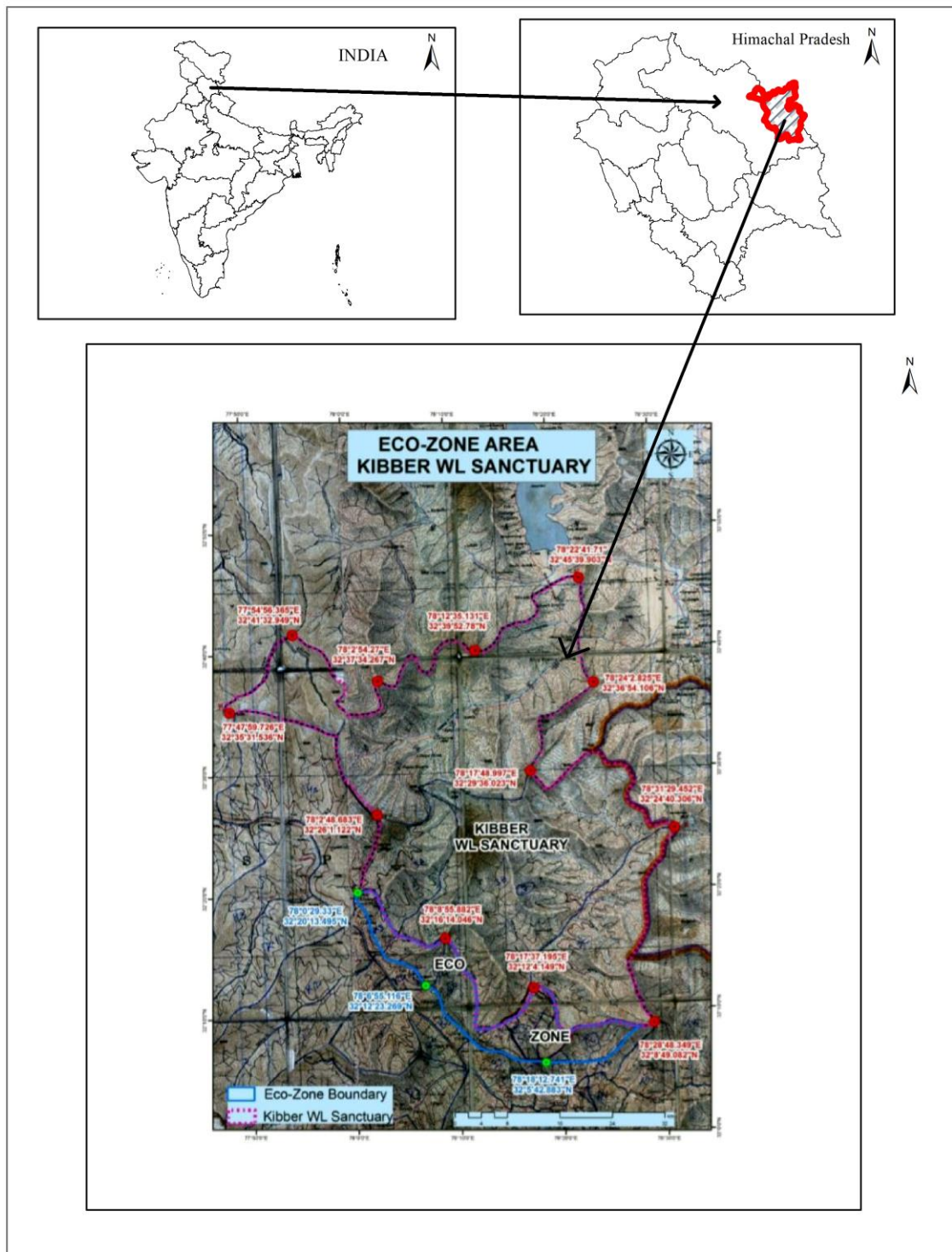
Hamid and Raina (2019) studied the life form and biological spectrum of Indus valley and reported 208 plant species, 121 genera and 49 families in lower Laddakh region of Jammu and Kashmir. Lower Laddakh region has low species diversity with higher percentage of annuals and biennials where few tree species are found along the river in the valley.

Rinchen *et al.* (2019) stated that the density and diversity of wild Manu (*Inula racemosa*) were drastically declined in cold desert region of North Western Himalaya. The efforts are needed to provide technical support for cultivation, establishment of value addition centers and strengthen the market.

Pandey *et al.* (2018) stated that cold desert region harbor a unique habitat for a number of high value medicinal plants and inhabitants of the regions are highly depended on medicinal plants. 22 threaten plants were identified from cold desert areas in Johar valley, Kailash Sacred Landscape India.

Sharma *et al.* (2018) reported 91 species of wild edible plants (tree 01 sp.; shrubs 11 spp. & herbs 79 spp.) belonging to 64 genera in 31 families. Polygonaceae and Asteraceae were dominate families followed by Apiaceae. Allium, Ribes, Chenopodium, Hippophae and Rheum were the rich genera.

Verma and Tewari (2016) conducted a study on some medicinally important plants of cold desert in Kinnaur district of Himachal Pradesh. During their survey they reported 113 plants of medicinal importance, out of which 22 were fully examined for their habitat, plant part used, uses and chemical ingredient. In their study, 11 plants out of total 22 plants fall under the threatened category of IUCN red list.



**Figure-1: Map of Kibber Wildlife Sanctuary.**



These were *Aconitum heterophyllum*, *Arnebia euchroma*, *Betula utilis*, *Dactylorhiza hatagirea*, *Ephedra gerardiana*, *Hippophae rhamnoides*, *Hyssopus officinalis*, *Hyoscyamus niger*, *Jurinea dolomiaea*, *Picrorhiza kurroo*, *Rhododendron companulatum*. This rarity in the medicinal plant may be due to narrow range of distribution, habitat alteration, over grazing and overharvesting.

Deshmukh and Jain (2016) reported 117 plant species in the Miyar valley of Lahaul and Spiti, out of which 11 were trees, 12 were shrubs and 94 were herbs. They reported that Asteraceae, Fabaceae, Lamiaceae and Polygonaceae were the dominant families. Species diversity index in the valley was observed 1.68 to 2.08 for trees, 1.64 to 2.27 for shrubs and 3.19 to 3.85 for herbs. Some herbs like *Allium stracheyi*, *Saussurea costus*, *Dactylorhiza hatagirea*, *Eremurus himlalaicus*, *Podophyllum hexandrum* etc. were having high conservation value.

Sekar *et al.* (2014) conducted a floristic diversity survey in Milam valley of Uttarakhand and observed 181 plant species belonging to 39 families and 95 genera. About 41% of plants were represented by five family, Ranunculaceae among them being the most dominant comprising about 11% of the total species followed by Asteraceae and Cyperaceae both having 7.7% of total plant species while Rosaceae and Polygonaceae account 7.2% and 6.6%, respectively. The maximum density was recorded 3.1 ind./m<sup>2</sup> for *Thymus linearis* and minimum was observed 0.1 ind./m<sup>2</sup> for *Rheum moorcroftianum*. *Danthonia schneideri* and *Poa alpine* were most abundant among the grasses having density 8.50 ind./m<sup>2</sup> and 4.2 ind./m<sup>2</sup> respectively.

Verma, 2014, conducted a floristic study in Hango valley of cold desert in District Kinnaur and reported 130 plant species belonging to 41 families and 101 genera. Asteraceae, Polygonaceae, Ranunculaceae, Lamiaceae and Umbelliferi were the dominant families. The tree species were three with dominance of *Salix alba* at an altitudinal gradient of 3400-3800 m. Number of shrubs species were 9, 5, 3 and 2 for an altitudinal gradient of 3400-3800 m, 3800-4200 m, 4200-4600 m and 4600-5000 m with dominance of *Rosa webbiana*, *Cotoneaster microphyllus*, *Juniperus indica* and *Rhododendron anthopogon* respectively. The number of herb species were 73, 63, 36 and 30 for the altitudinal gradient of 3400-3800 m, 3800-4200 m, 4200-4600 m and 4600-5000 m respectively. *Heracleum candicans* was dominant species of herb at 3400-3800 m while *Bergenia stracheyi* was dominant for rest of the heights.

The cold desert terrain is formed of plains, plateaus, hills and valleys. In cold desert region soil generally have very low water retention capacity and thus scanty plant cover. The soil is light grey in color and fertility is very low. Due to lack of leaching mineral bases are continuously added to the soil thus shifting the pH of the soil toward alkalinity ranging between 7.4 to 9.4 (Tewari and Kapoor, 2013).

Viraj Man *et al.* (2012) conducted a study to understand the plant diversity and phytosociological attributes of the Porang valley in Liippa-Asrang wild life sanctuary. They reported 138 plant species belonging to 93 genera and 38 families. Total number of plant species was 6 with for the gradient 3300-3800 m with dominance of *Juniperus polycarpus*. Number of shrubs species were 17 and 7 with *Juniperus indica* and *Berberis jaeschkeana* being the dominant at altitude of 3300-3800 m and 3800-4300 m respectively. Total herbs species found were 80, 51 and 33 for altitudinal gradient of 3300- 3800 m, 3800-4300 m and 4400-5000 m., the dominant herbs were *Thymus linearis*, *Potentolla cuneata* and *Arenaria bryophylla* respectively.

Verma and Kapoor (2011) in their floristic study in Ropa- Giavung valley reported a total 160 species of plants belonging to 51 families and 119 genera. The altitudinal variation of plants species was observed between 3000-5000 m. the tree species was found only in altitudinal gradient of 3000-3500 having only 12 species of plants with dominance of *Pinus gerardiana*. Shrubs species were extended to height of 4000 m. Total shrubs species present were 20 and 15 with dominance of *Rosa webbiana* and *Juniperus indica* for the altitudinal gradient of 3000-3500 m and 3500- 4000 m. Shrubs species were noted at all altitudinal gradient having total number of 83, 46, 44 and 30 at 3000- 3500 m, 3500-4000 m, 4000-4500 m and 4500-5000 m with dominance of *Ephedra gerardiana*, *Artemesia brevifolia*, *Bistorta affinis* and *Potentilla argyrophylla* respectively.

Anup Raj and Sharma (2010) stated that the relative dominance of *Ephedra gerardiana* and *Berberis ulicina* has increased with increasing aridity of sites in high altitude desert of Laddakh. Maximum species turnover rate was recorded across the sites along streams where as the species were more similar within the xeric sites.

Verma and Kapoor (2010) conducted a floristic survey in Pooh valley, along an altitudinal gradient of 2700- 4200 m above msl. In their study, they reported a total 192 plant species belonging to 55 families and 136 genera. There was variation of dominant plant species along the gradient, as total number of tree species was found to be 13 and 5 with dominance of *Salix alba* and *Juniperus polycarpus* at altitudinal gradient of 2700-3200 m and 3200-3700 m, respectively. The shrub species was extended to an elevation of 4200 m. the number of shrub species at altitudinal gradient of 2700-3200, 3200-3700 and 3700-4200 was 22, 15 and 11 with dominance of *Rosa webbiana*, *Rosa webbiana* and *Juniperus indica* respectively. Similarly the number of herbs species comes out to be 83, 77 and 72 for the altitudinal gradient of 2700-3200 m, 3200-3700 m and 3700-4200 m with dominance of *Artemesia scoparia*, *Origanum vulgare* and *Bergenia strecheyi* respectively. The above result indicated that the number of plants species decreases with increase in altitude.

Shrivastav (2010) reported 1405 species, 490 genera and 98 families of flowering plant in cold desert of western Himalayas. *Allium carolinianum*, *Astragalus malacophyllus*, *Cremanthodium decaisnei*, *Draba cachemirica*, *Eremurus himalaisus*, *Galium tibeticum*, *Geranium pseudo-aconitifolium*, *Oxytropis sericopetala*, *Poa ladakhensis*, *Primula obtusiloba*, *Rhodiola brunonii*, *Rhodiola tibetica*, *Saussurea bracteata*, *Stellaria pusilla*, *Thermopsis inflata*, *Thlaspi cochlearioides*, *Thylacospermum caespitosum*, and *Viola kunawarensis* are threaten species found in the cold desert.

Rawat *et. al.* (2009) recorded about 118 species of plants that were medicinally or aromatically important from different localities of Spiti valley. In their study they reported that the occurrence of medicinal and aromatic plant species was sparse and were dependent on soil moisture and thickness of the soil. Due to overexploitation, unscientific collection and over grazing most of the species have come under different IUCN Red list category. Ved *et al.* 2003, has listed *Arnebia euchroma*, *Dactylorhiza heterogirea*, *Gentiana kurroo*, *Saussurea obvallata* as critically endangered, *Betula utilis*, *Ephedra gerardiana*, *Hyoscyamus niger*, *Junipeus polycarpus*, *Picrorhiza kurrooa*, *Podophyllum hexandrum*, *Rheum emodi*, *Rheum moorcraftianum* as endangered and *Aconitum violaceum*, *Allium stracheyi*, *Bergenia strecheyi*, *Ferula jaeskeana*, *Heracleum lanatum*, *Hippophae rhamnoides*, *Hyssopus officinalis*, *Rhodiola heterodonta*, *Rhododendron anthopogon* as vulnerable.

The vegetation in cold desert is scanty. The most of the vegetation is composed of herbs while shrubs and trees are scattered in patches. Negi (2008) reported that natural forest wealth in Trans-Himalayan cold desert zone constitutes few scattered trees of Chilgoza Pine, Poplar, Juniper and Willow. *Artemesia*, *Hippophae*, *Ephedra*, Wild rose and a few other are the shrubs found generally.

Verma *et. al.* (2008), studied the forest vegetation along altitudinal gradient in Labrang valey of District Kinnaur, Himachal Pradesh. In their study they observed that only 11 species of tree were present at an altitude of 3000-3500 m, with dominance of *Cedrus deodara*. Similarly, the number of shrub species also declined with elevation in altitude and only 21, 16, 8 species of shrubs were reported at altitudinal range of 3000- 3500m, 3500-4000 m and 4000- 4500 m respectively. Herbs species were reported even at altitudinal range of 4500-5000 m also. However their number also decreases with increase in altitudinal height. The numbers of species for herbs reported were 83, 82, 38 and 25 at altitudinal range of 3000- 3500m, 3500-4000 m and 4000- 4500 m, 4500-5000 m, respectively. The index of similarity for shrubs and herbs species was low that indicated the remarkable degree of dissimilarity in plant species exist between different

altitudinal gradient. They also reported 75 plants species that were of medicinal importance out of which 11 were found to fall in the threatened species category of IUCN.

Singh and Gupta (1990) carried out study on soil and vegetation of Lahaul Spiti. They found that soil was silty clay loam in most of the locality in Lahaul sub-division while in Spiti sub division soil was silty loam and silty clay loam. The soil was alkaline & pH ranging to 7.2 to 8.1 and poor in organic matter. Among nutrients, calcium was found in most concentration followed by potassium, sodium and phosphorus in decreasing order. Due to poor vegetation and leaching the mineral are continuously added to the soil thus increasing the pH. The vegetation was not uniform and was present in patches near the water courses and where moisture was available to plant. On the bases of Importance Value Index (IVI) calculated *Hippophae rhamnoides* was found to have maximum value of 63.31 followed by *Rosa webbiana*, *Ephedra gerardiana*, *Caragana pygmaea*, *Poa pratensis*, *Rumex nepalensis*, *Myricaria prostrata*, *Chenopodium hybridum*, *Cotoneaster mummularia*, *Lonicera spinosa*, *Agropyron repens*, *Erogrostis superb* and *Trigonella polycerata* having I.V.I value of 46.52, 24.59, 22.13, 20.15, 19.79, 17.25, 15.63, 14.95, 14.39, 14.33 and 14.09, respectively.

## 15. Materials and Methods

The sites to carry out the studies were finalized after carrying out thorough survey of Kibber Wild Life sanctuary. Twelve sites were selected in Kibber Wild Life Sanctuary. The name of sites are Badang, Dhinam, Chicham-1, Chhicham-2, Gete, Ladarcha, Rachmolaka Nalla, Gypsian lumpa, Chumik shartey, Langza, Komik, and Demul. The detail information of selected study sites are given in table-1. Studies for vegetation including shrubs and herbs were carried out by laying out the quadrats randomly along or across the selected altitudinal gradients. Trees were not found in study sites. Detailed information with reference to floristic and related ecological parameters were recorded for each site (Table 1). Altitudinal range was stratified after carrying out preliminary survey.

The phyto-sociological analysis of data was carried out of twelve sites in Kibber Wildlife Sanctuary. Data was collected at an altitudinal zonation of 4400-4800 m, and greater than 4800 m, whereas in Chicham-1, only altitudinal range was also observed between 4200 m to 4800 m. The study sites i.e. Rachmolaka Nalla and Gypsian lumpa had the vegetation only in altitudinal range between 4400-4800 m. The quadrates for phytosociological data collection were drawn randomly of the size 1x1 m for herbs and 5x5 m for shrubs. The vegetation was analyzed by calculating the density, frequency, abundance, IVI using the formulas given by Curtis and Macintosh (1950). The relative values of density, frequency and

dominance were summed to get Importance Value Index (IVI) of individual species. The abundance to frequency ratio (A/F) of different species was determined for eliciting the distribution pattern. This ratio indicated regular ( $<0.025$ ), random ( $0.025$  to  $0.050$ ) and contiguous ( $>0.050$ ) distribution (Curtis and Cottam, 1956). The plant species diversity was calculated by using Shanon-Wiener diversity Index (H) (Shannon-Wiener, 1963). Concentration of dominance (C) was measured by Simpson's Index (Simpson, 1949). Richness Index was estimated as per Margalef (1958) *i.e.*  $R = S - 1/\ln N$  whereas Evenness Index was calculated as per Hill (1973) *i.e.*  $E = H/\ln S$ , where  $S$ = total number of species,  $N$ = total number of individuals of all the species,  $H$  = Index of diversity.

For each location, samples from 0-30 cm were drawn randomly and were thoroughly mixed to cover the entire area. 4 samples per sites were collected. Soil samples were air dried, grinded and passed through 2 mm sieve for their physico-chemical analysis.

Soil moisture (Gupta, 2002), pH (Jackson, 1973), electrical conductivity (Jackson, 1973), organic carbon (Piper, 1966), available nitrogen (Subbia and Asija, 1956), available phosphorus (Olsen *et al.*, 1954) and available potassium (Merwin and Peech, 1951) were calculated as per above standard procedures to know the fertility status of the soil.

## 16. Results and Discussion

Survey was carried out in Langza, Kibber and Lalung beats of Kibber Wildlife Sanctuary. Phytosociological analysis has been carried out for twelve sites *i.e.* Badang, Dhinam, Chicham-1, Chhicham-2, Gete, Ladarcha, Rachmolaka Nalla, Gypsian lumpa, Chumik shartey, Langza, Komik, and Demul.

Total 116 plant species were recorded belonging to 71 genus and 33 families during floristic survey in Kibber WLS which includes 9 species of shrubs and 107 species of herbs (Table -2). The results of floristic survey revealed that the dominant family was Asteraceae followed by Fabaceae and Rosaceae. The 101 species were observed in the selected 12 sampling sites (The details of species are given in Table-3 to Table-46). In addition to above, 15 number of species were only recorded during floristic survey *i.e.* *Carum carvi*, *Corydalis filiformis*, *Erigeron multiradiata*, *Eriophyton rhomboideum*, *Heracleum thomsonii*, *Marmoritis nivalis*, *Myricaria prostrata*, *Nepeta longibracteata*, *Oxytropis lapponica*, *Oxytropis sp.*, *Oxytropis tatarica*, *Pedicularis bicornuta*, *Pedicularis longifolia*, *Tragopogon gracilis* and *Waldheimia glabra*.

**Table 1: Geo-coordinates and other information of the study sites.**

S.No.	Site Name	Beat	Altitude Range (m)	Aspect	Slope	Altitude (m)	Latitude	Longitude
1	Badang	Kibber	4400-4800	NW	10°-30°	4508	N32°21'01.8"	E078°02'05.2"
			>4800	NW	25°-35°	4881	N32°21'19.8"	E078°02'54.6"
2	Dhinam	Kibber	4400-4800	NW	10°-30°	4956	N32°18'47.9"	078°03'15.4"
			>4800	NW	15°-35°	5025	N32°18'55.1"	E078°03'13.7"
3	Chichham-1	Kibber	< 4400	NW	25°-40°	4327	N32°22'17.0"	077°00'04.5"
			4400-4800	NW	25°-35°	4457	N32°22'20.9"	E078°00'18.1"
4	Chichham-2	Kibber	4400-4800	NW	20°-35°	4468	N32°23'51.2"	077°58'61.2"
			>4800	NW	30°-35°	4924	N32°24'10.2"	078°00'00.4"
5	Gete	Kibber	4400-4800	NW	5°-25°	4488	N32°18'29.6"	E078°01'54.7"
			>4800	NW	25°-40°	4807	N32°18'54.7"	E078°02'44.8"
6	Ladarcha	Kibber	4400-4800	NW	25°-35°	4467	N32°23'54.1"	E077°57'35.2"
			>4800	NW	25°-40°	4844	N32°18'54.7"	E078°02'44.8"
7	Racholakmo	Kibber	4400-4800	NE	10°-35°	4597	N32°37'43.5"	E078°19'12.3"
8	Gipsian Lumpa	Kibber	4400-4800	NE	15°-35°	4561	N32°38'54.9"	E078°20'37.9"
9	Chumik Shaltay	Kibber	4400-4800	NW-NE	10°-35°	4620	N32°41'50.5"	E078°20'29.0"
			>4800	NW-NE	25°-40°	5006	N32°41'05.6"	E078°20'48.4"
10	Langza	Langza	4400-4800	NW	10°-30°	4620	N32°17'09.2"	E078°06'12.2"
			>4800	NW	20°-35°	4867	N32°16'13.3"	E078°07'31.2"
11	Komik	Langza	4400-4800	NW	15°-35°	4732	N32°14'31.7"	E078°07'02.3"
			>4800	NW	26°-35°	5006	N32°15'50.3"	E078°07'36.2"
12	Demul	Lalung	4400-4800	NW	20°-25°	4783	N32°11'02.6"	E078°09'43.8"
			>4800	NW	25°-35°	4995	N32°12'12.6"	E078°08'49.4"

**Table 2: Family and habit species found in the Kibber Wildlife Sanctuary.**

S. No.	Name of Plant	Family	Habit
1	<i>Aconitum</i> sp.	Ranunculaceae	Herb
2	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	Polygonaceae	Herb
3	<i>Allium carolinianum</i> DC.	Amaryllidaceae	Herb
4	<i>Allium consanguineum</i> Kunth	Amaryllidaceae	Herb
5	<i>Alyssum desertorum</i> Stapf	Brassicaceae	Herb
6	<i>Androsace delavayi</i> Franch.	Primulaceae	Herb
7	<i>Arabidopsis himalaica</i> (Edgew.) O. E. Schulz	Brassicaceae	Herb
8	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	Boraginaceae	Herb
9	<i>Artemisia gmelinii</i> Weber ex Stechm.	Asteraceae	Herb
10	<i>Artemisia salsoloides</i> Willd.	Asteraceae	Herb
11	<i>Artemisia santolinifolia</i> Turcz ex Krasch.	Asteraceae	Herb
12	<i>Artemisia</i> sp.	Asteraceae	Herb
13	<i>Askellia flexuosa</i> (Ledeb.) W. A. Weber	Asteraceae	Herb
14	<i>Aster flaccidus</i> Bunge	Asteraceae	Herb
15	<i>Astragalus candolleanus</i> Royle ex Benth.	Fabaceae	Herb
16	<i>Astragalus</i> sp.	Fabaceae	Herb
17	<i>Astragalus nivalis</i> Kar & Kir	Fabaceae	Herb
18	<i>Astragalus rhizanthus</i> Benth.	Fabaceae	Herb
19	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	Saxifragaceae	Herb
20	<i>Biebersteinia odora</i> Stephan ex Fisch.	Biebersteiniaceae	Herb
21	<i>Bistorta affinis</i> (D.Don) Greene	Polygonaceae	Herb
22	<i>Calamogrostis</i> sp.	Poaceae	Grass
23	<i>Caragana versicolor</i> (Wall.) Benth.	Fabaceae	Shrub
24	<i>Carex</i> sp.	Cyperaceae	Grass
25	<i>Carum carvi</i> Linn.	Apiaceae	Herb
26	<i>Chenopodium glaucum</i> Linn.	Amaranthaceae	Herb
27	<i>Christolea crassifolia</i> Cambess.	Brassicaceae	Herb
28	<i>Christolea himalayensis</i> (Cambess.) Jafri	Brassicaceae	Herb
29	<i>Corydalis crassifolia</i> Royle	Papaveraceae	Herb
30	<i>Corydalis filiformis</i> Royle	Papaveraceae	Herb
31	<i>Corydalis thyrsiflora</i> Prain	Papaveraceae	Herb
32	<i>Cousinia thomsonii</i> C. B. Clarke	Asteraceae	Herb
33	<i>Dracocephalum heterophyllum</i> Benth.	Lamiaceae	Herb
34	<i>Dracocephalum</i> sp.	Lamiaceae	Herb
35	<i>Elsholtzia eriostachya</i> (Benth.) Benth.	Lamiaceae	Herb

36	<i>Elymus nutans</i> Griseb.	Poaceae	Grass
37	<i>Ephedra gerardiana</i> Wall. ex Stapf	Ephedraceae	Shrub
38	<i>Erigeron multiradiata</i> (DC) Bth. ex Cl.	Asteraceae	Herb
39	<i>Erigeron poncinsii</i> (Franch.) Botsch.	Asteraceae	Herb
40	<i>Eriophyton rhomboideum</i> (Benth.) Ryding	Lamiaceae	Herb
41	<i>Eritrichium canum</i> (Benth.) Kitam.	Boraginaceae	Herb
42	<i>Euphorbia tibetica</i> Boiss.	Euphorbiaceae	Herb
43	<i>Festuca</i> sp.	Poaceae	Grass
44	<i>Gagea lutea</i> (L.) Ker Gawl.	Liliaceae	Herb
45	<i>Gentiana moorcroftiana</i> (Wall. ex Griseb.) Airy Shaw	Gentianaceae	Herb
46	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	Gentianaceae	Herb
47	<i>Geranium lambertii</i> Sweet	Geraniaceae	Herb
48	<i>Geranium himalayense</i> Klotzsch	Geraniaceae	Herb
49	<i>Geranium wallichianum</i>	Geraniaceae	Herb
50	<i>Marmoritis nivalis</i> (Benth.) Hedge	Lamiaceae	Herb
51	<i>Heracleum pinnatum</i> C.B. Clarke	Apiaceae	Herb
52	<i>Heracleum thomsonii</i> C.B. Clarke	Apiaceae	Herb
53	<i>Kobresia royleana</i> (Nees) Boeckeler	Cyperaceae	Grass
54	<i>Kobresia schoenoides</i> (C.A.Mey.) Steud.	Cyperaceae	Grass
55	<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	Amaranthaceae	Shrub
56	<i>Lactuca tatarica</i> (L.) C.A.Mey.	Asteraceae	Herb
57	<i>Leontopodium himalayanum</i> DC.	Asteraceae	Herb
58	<i>Lepidium apetalum</i> Willd	Brassicaceae	Herb
59	<i>Lindelofia longiflora</i> (Benth.) Baill.	Boraginaceae	Herb
60	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	Boraginaceae	Herb
61	<i>Lonicera semenovii</i> Regel	Caprifoliaceae	Shrub
62	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	Caprifoliaceae	Shrub
63	<i>Myosotis alpestris</i> F. W. Schmidt	Boraginaceae	Herb
64	<i>Myricaria germanica</i> (L.) Desv.	Tamaricaceae	Shrub
65	<i>Myricaria prostrata</i> Hook. f. & Thomson	Tamaricaceae	Shrub
66	<i>Nepeta eriostachya</i> Benth.	Lamiaceae	Herb
67	<i>Nepeta longibracteata</i> Benth.	Lamiaceae	Herb
68	<i>Nepeta podostachys</i> Benth.	Lamiaceae	Herb
69	<i>Nepeta</i> sp.	Lamiaceae	Herb
70	<i>Oxytropis cachemiriana</i> Cambess.	Fabaceae	Herb
71	<i>Oxytropis lapponica</i> (Wahlenb.) Gay	Fabaceae	Herb
72	<i>Oxytropis microphylla</i> (Pall.) DC.	Fabaceae	Herb
73	<i>Oxytropis mollis</i> Benth.	Fabaceae	Herb



74	<i>Oxytropis sp.</i>	Fabaceae	Herb
75	<i>Oxytropis tatarica</i> Baker	Fabaceae	Herb
76	<i>Paraquilegia microphylla</i> (Royle) J.R Drumm. & Hutch.	Ranunculaceae	Herb
77	<i>Pedicularis bicornuta</i> Klotz. Ex Klotz. & Garcke	Orobanchaceae	Herb
78	<i>Pedicularis longifolia</i> (Klotzsch) Tsoong	Orobanchaceae	Herb
79	<i>Physochlaina praealta</i> (Walp.) Miers.	Solanaceae	Herb
80	<i>Plantago depressa</i> Willd.	Plantaginaceae	Herb
81	<i>Plantago sp.</i>	Plantaginaceae	Herb
82	<i>Polygonum cognatum</i> Meisn.	Polygonaceae	Herb
83	<i>Potentilla arbuscula</i> D. Don	Rosaceae	Shrub
84	<i>Potentilla argrophylla</i> Wall. ex Lehm.	Rosaceae	Herb
85	<i>Potentilla bifurca</i> Linn.	Rosaceae	Herb
86	<i>Potentilla desertorum</i> Bunge	Rosaceae	Herb
87	<i>Potentilla multifida</i> L.	Rosaceae	Herb
88	<i>Potentilla nivea</i> Linn.	Rosaceae	Herb
89	<i>Potentilla sp.</i>	Rosaceae	Herb
90	<i>Rhamnus prostrata</i> Jacq. ex Parker	Rhamnaceae	Shrub
91	<i>Rheum spiciforme</i> Royle	Polygonaceae	Herb
92	<i>Rheum tibeticum</i> Maxim. ex Hook. f.	Polygonaceae	Herb
93	<i>Rhodiola crenulata</i> (Hook. f. & Th.) H. Obha	Crassulaceae	Herb
94	<i>Rhodiola heterodonta</i> (Hook. f. & Thomson) Boriss	Crassulaceae	Herb
95	<i>Rhodiola tibetica</i> (Hook.f. & Thomson) S.H. Fu	Crassulaceae	Herb
96	<i>Rhodiola wallichiana</i> (Hook.) S.H. Fu	Crassulaceae	Herb
97	<i>Ribes orientalis</i> Desf.	Grossulariaceae	Herb
98	<i>Rosularia alpestris</i> (Kar. & Kir.) Boriss.	Crassulaceae	Herb
99	<i>Salsola collina</i> Pall.	Amaranthaceae	Herb
100	<i>Saussurea glacialis</i> Herder.	Asteraceae	Herb
101	<i>Saussurea taraxicifolia</i> Wall. ex DC.	Asteraceae	Herb
102	<i>Saussurea nana</i> (Pamp.) Pamp.	Asteraceae	Herb
103	<i>Scrophularia dentata</i> Royle ex Benth	Scrophulariaceae	Herb
104	<i>Silene gonosperma</i> (Rupr.) Bocquet	Caryophyllaceae	Herb
105	<i>Silene rechingeri</i> Bocquet	Caryophyllaceae	Herb
106	<i>Stipa capillata</i> Linn.	Poaceae	Grass
107	<i>Stipa sp.</i>	Poaceae	Grass
108	<i>Tanacetum nubigenum</i> Wall. ex DC.	Asteraceae	Herb
109	<i>Taraxacum officinale</i> Wigg.	Asteraceae	Herb
110	<i>Thalictrum cultratum</i> Wall.	Ranunculaceae	Herb

111	<i>Thalictrum foetidum</i> Linn.	Ranunculaceae	Herb
112	<i>Thermopsis inflata</i> Cambess.	Fabaceae	Herb
113	<i>Thymus linearis</i> Benth.	Lamiaceae	Herb
114	<i>Tragopogon gracilis</i> D. Don	Asteraceae	Herb
115	<i>Urtica hyperborea</i> Jacq. Ex Wedd.	Urticaceae	Herb
116	<i>Waldheimia glabra</i> (Decne.) Regel	Asteraceae	Herb

Total 101 plant species were recorded belonging to 65 genus and 32 families for woody and non woody vegetation in 12 sampling study sites.







**1. Name of Site: Badang (Kibber beat)**

**a) Altitude Range: 4400 m - 4800 m**

Phytosociological analysis of shrubs (Table 3) in Badang showed that four species of shrubs were recorded. *Caragana versicolor* (209.93) was dominant species on the basis of IVI and least dominant was *Ephedra gerardiana* (24.74). *Caragana versicolor* showed highest value for density/ m<sup>2</sup> (6.13) and lowest value (0.45) was observed for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (45.00) and minimum was observed (12.50) for *Ephedra gerardiana* and *Lonicera spinosa*. Maximum abundance was observed for *Caragana versicolor* (13.61) and minimum (3.60) was observed for *Lonicera spinosa*. The ratio of A/F for shrubs indicated that the distribution pattern of all the species was contiguous (Table 3) and has also been reported by several workers (Kershaw, 1973; Singh and Yadav, 1974 and Kunhikannan *et al.*, 1998). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 1.06, 0.83, 0.52 and 0.60, respectively at Badang.


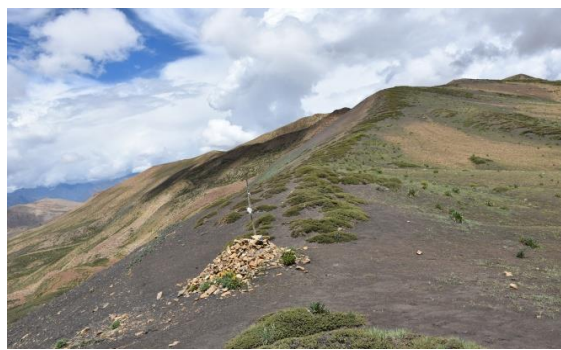




**Table-3: Phytosociological attributes of shrubs in Badang at an altitudinal range between 4400 m - 4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	6.13	45.00	13.61	0.302	209.93
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.58	12.50	4.60	0.368	24.74
3	<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	0.80	15.00	5.33	0.356	37.16
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.45	12.50	3.60	0.288	28.17

	
<b>Name of study site: Langza</b>	<b>Name of study site: Langza</b>
	
<b>Name of study site: Demul</b>	<b>Name of study site: Demul</b>
	
<b>Name of study site: Badang</b>	<b>Name of study site: Badang</b>







**Plate-1: Photographs of study sites**



	
<b>Name of study site: Komik</b>	<b>Name of study site: Komik</b>
	
<b>Name of study site: Gete</b>	<b>Name of study site: Gete</b>
	
<b>Name of study site: Dhinam</b>	<b>Name of study site: Dhinam</b>







**Plate-2: Photographs of study sites**



	
<b>Name of study site: Chhicham-1</b>	<b>Name of study site: Chhicham-1</b>
	
<b>Name of study site: Chhicham-2</b>	<b>Name of study site: Chhicham-2</b>
	
<b>Name of study site: Ladarcha</b>	<b>Name of study site: Ladarcha</b>

**Plate-3: Photographs of study sites**



	
<b>Name of study site: Gipsian lumpa</b>	<b>Name of study site: Gipsian lumpa</b>
	
<b>Name of study site: Racholakmo</b>	<b>Name of study site: Racholakmo</b>
	
<b>Name of study site: Chumik Shaltay</b>	<b>Name of study site: Chumik Shaltay</b>

**Plate-4: Photographs of study sites**

Phytosociological analysis of herbs (Table-4) at Badang showed that total number of species of herbs was 16. *Elymus nutans* (61.64) was dominant species on the basis of IVI followed by *Allium carolinianum* (49.73), *Lindelofia stylosa* (34.55) and least dominant was *Arabidopsis himalaica* (6.14). *Elymus nutans* showed highest value for density/m<sup>2</sup> (2.80) followed by *Allium carolinianum* (0.70), *Leontopodium himalayanum* (0.45), *Lindelofia stylosa* (0.38) and lowest value (0.10) was observed for *Arabidopsis himalaica*. Maximum frequency % was observed for *Allium carolinianum* (15.00) followed by *Elymus nutans* (12.50), *Corydalis thyrsoflora* (10.00) and *Cousinia thomsonii* (10.00) and minimum value (5.00) was observed for *Arabidopsis himalaica*, *Polygonum cognatum* and *Potentilla bifurca*. Maximum abundance was observed for *Elymus nutans* (22.40) followed by *Leontopodium himalayanum* (5.45), *Allium carolinianum* (4.67) and minimum value (2.00) was observed for *Arabidopsis himalaica*. The ratio of A/F for herbs indicated that the distribution pattern of all the species was contiguous. Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.11, 2.47, 2.64 and 0.89, respectively (Table-47). The results are in line with Hamid and Raina (2019), Verma and Tewari (2016), Verma (2014) and Shrivastav (2010). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.87, 7.77 and 78.14, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.85, 160.00, 7.14 and 338.72 respectively. Medium organic carbon (%) was observed. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table-4: Phytosociological attributes of herbs species in Badang at an altitudinal range between 4400 m - 4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Allium carolinianum</i> DC.	0.70	15.00	4.67	0.311	49.73
2	<i>Arabidopsis himalaica</i> (Edgew.) O. E. Schulz	0.10	5.00	2.00	0.400	6.14
3	<i>Astragalus rhizanthus</i> Benth.	0.30	7.50	4.00	0.533	13.32
4	<i>Corydalis thyrsoiflora</i> Prain	0.40	10.00	4.00	0.400	14.33
5	<i>Cousinia thomsonii</i> C. B. Clarke	0.33	10.00	3.25	0.325	32.10
6	<i>Elymus nutans</i> Griseb.	2.80	12.50	22.40	1.792	61.64
7	<i>Eritrichium canum</i> (Benth.) Kitam.	0.33	7.50	4.33	0.578	11.78
8	<i>Leontopodium himalayanum</i> DC.	0.45	8.25	5.45	0.661	13.81
9	<i>Lindlofia stylosa</i> (Kar. & Kir.) Brand	0.38	15.00	2.50	0.167	34.55
10	<i>Oxytropis mollis</i> Benth.	0.30	7.50	4.00	0.533	11.06
11	<i>Polygonum cognatum</i> Meisn.	0.23	5.00	4.50	0.900	7.68
12	<i>Potentilla bifurca</i> Linn.	0.15	5.00	3.00	0.600	6.23
13	<i>Potentilla</i> sp.	0.20	7.50	2.67	0.356	8.85
14	<i>Taraxacum officinale</i> Wigg.	0.15	7.50	2.00	0.267	9.04
15	<i>Thalictrum cultratum</i> Wall.	0.30	7.50	4.00	0.533	10.39
16	<i>Thalictrum foetidum</i> Linn.	0.23	7.50	3.00	0.400	9.35



**b) Altitude Range: > 4800 m**

A perusal of table 5 for shrubs at Badang showed that total number of shrubs species was 2. *Caragana versicolor* (262.36) was dominant on the basis of IVI and least dominant was *Lonicera spinosa* (37.64). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (5.63) and lowest value (0.45) was observed for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (42.50) and minimum value (15.00) was observed for *Lonicera spinosa*. Maximum abundance was observed for *Caragana versicolor* (13.24) and minimum value (3.00) was observed for *Lonicera spinosa*. Contiguous distribution pattern was observed for all the shrubs species at Langza (Table 5). A perusal of table 47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.78, 0.38, 0.18 and 0.55, respectively at Badang.

**Table.5: Phytosociological attributes of shrubs in Badang at an altitudinal range >4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	5.63	42.50	13.24	0.311	262.36
2	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.45	15.00	3.00	0.200	37.64

A perusal of table 6 for herbs at Badang showed that total number of herbs species was 11. *Elymus nutans* (102.33) was dominant species on the basis of IVI followed by *Stipa capillata* (72.91), *Bergenia stracheyi* (42.78) and least dominant was *Aconitum* sp. (5.29). *Elymus nutans* showed highest value for density/m<sup>2</sup> (15.85) followed by *Stipa capillata* (8.63), *Bergenia stracheyi* and *Corydalis thyrsoiflora* (0.45) and lowest value (0.08) was observed for *Aconitum* sp. Maximum frequency % was observed for *Elymus nutans* (20.00) followed by *Bergenia stracheyi* (15.00), *Stipa capillata* (12.50) and minimum value (5.00) was observed for *Aconitum* sp., *Rheum spiciforme* and *Saussurea nana*. Maximum abundance was observed for *Elymus nutans* (79.25) followed by *Stipa capillata* (69.00), *Corydalis thyrsoiflora* (6.00) and minimum value (1.50) was observed for *Aconitum* sp. Contiguous distribution pattern was observed for all the herbs species at Badang (Table 6). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.21, 1.89, 1.44 and 0.79, respectively (Table- 47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.20, 7.72 and 33.31, respectively. Organic carbon (%),

available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.35, 112.00, 6.29 and 343.38, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 6: Phytosociological attributes of herbs species in Badang at an altitudinal range >4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconitum</i> sp.	0.08	5.00	1.50	0.300	5.29
2	<i>Allium carolinianum</i> DC.	0.30	10.00	3.00	0.300	17.39
3	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	0.45	15.00	3.00	0.200	42.78
4	<i>Corydalis thyrsiflora</i> Prain	0.45	7.50	6.00	0.800	9.86
5	<i>Elymus nutans</i> Griseb.	15.85	20.00	79.25	3.963	102.33
6	<i>Oxytropis mollis</i> Benth.	0.13	7.50	1.67	0.222	8.51
7	<i>Potentilla argrophylla</i> Wall. ex Lehm.	0.23	7.50	3.00	0.400	9.53
8	<i>Rheum spiciforme</i> Royle	0.15	7.50	2.00	0.267	12.29
9	<i>Rheum tibeticum</i> Maxim. ex Hook. f.	0.10	5.00	2.00	0.400	5.58
10	<i>Saussurea nana</i> (Pamp.) Pamp.	0.15	5.00	3.00	0.600	13.52
11	<i>Stipa capillata</i> Linn.	8.63	12.50	69.00	5.520	72.91

## 2. Name of Site: Dhinam

### a) Altitude Range: 4400m-4800 m

A perusal of table 7 for shrubs at site-Dhinam showed that total number of species of shrubs was 05. *Caragana versicolor* (210.64) was dominant species on the basis of IVI followed by *Ephedra gerardiana* (30.08) and least dominant was *Potentilla arbuscula* (13.93). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (5.15) followed by *Ephedra gerardiana* (1.13) and lowest value (0.48) was recorded for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (40.00) followed by *Ephedra gerardiana* and *Krascheninnikovia ceratoides* (10.00) and minimum value (5.00) was observed

for *Potentilla arbuscula*. Maximum abundance was observed for *Caragana versicolor* (12.88) followed by *Ephedra gerardiana* (30.08) and minimum value (13.93) was observed for *Potentilla arbu-scula*. The ratio of A/F indicated that the distribution pattern of all the species was contiguous for shrubs at Dhinam (Table 7). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 1.05, 0.93, 0.69 and 0.58, respectively at Dhinam.

**Table 7: Phytosociological attributes of shrubs in Dhinam at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	5.15	40.00	12.88	0.322	210.64
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.13	10.00	11.25	1.125	30.08
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	1.08	10.00	10.75	1.075	26.90
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.48	7.50	6.33	0.844	18.45
5	<i>Potentilla arbu-scula</i> D. Don	0.58	5.00	11.50	2.300	13.93

A perusal of table-8 for herbs at site-Dhinam showed that total number of species of herbs was 28. *Elymus nutans* (84.00) was dominant species on the basis of IVI followed by *Stipa* sp. (44.84), *Carex* sp. (17.82) and least dominant *Aconogonum tortuosum* (2.72). *Elymus nutans* showed highest value for density/m<sup>2</sup> (20.00) followed by *Stipa* sp. (3.65) and lowest value (0.15) was observed for *Astragalus rhizanthus*, *Gentiana moorcroftiana*, *Oxytropis mollis* and *Plantago depressa*. Maximum frequency % was observed for *Elymus nutans* (30.00) followed by *Cousinia thomsonii* (17.50), *Taraxacum officinale* (15.00) and minimum value (5.00) was observed for *Aconogonum tortuosum*. Maximum abundance was observed for *Elymus nutans* (66.67) followed by *Stipa* sp. (48.67), *Carex* sp. (30.75) and minimum was *Plantago depressa*. (1.50). The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table-8). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.12, 2.76, 3.73 and 0.83, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 6.21, 7.32, and

42.25, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.44, 117.60, 6.52 and 337.38, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table-8: Phytosociological attributes of herbs species in Dhinam at an altitudinal range between 4400 m-4800 m.**

S.No.	Name of Species	Density/m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	0.23	5.00	4.50	0.900	2.72
2	<i>Allium carolinianum</i> DC.	0.28	7.50	3.67	0.489	6.72
3	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	0.20	10.00	2.00	0.200	9.23
4	<i>Artemisia gmelinii</i> Weber ex Stechm.	0.30	10.00	3.00	0.300	7.88
5	<i>Astragalus rhizanthus</i> Benth.	0.15	7.50	2.00	0.267	3.34
6	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	0.23	12.50	1.80	0.144	5.74
7	<i>Carex</i> sp.	3.08	10.00	30.75	3.075	17.82
8	<i>Christolea crassifolia</i> Cambess.	0.48	15.00	3.17	0.211	8.02
9	<i>Corydalis thyrsiflora</i> Prain	0.43	10.00	4.25	0.425	5.33
10	<i>Cousinia thomsonii</i> C. B. Clarke	0.40	17.50	2.29	0.131	13.12
11	<i>Dracocephalum heterophyllum</i> Benth.	0.28	5.00	5.50	1.100	5.85
12	<i>Elsholtzia eriostachya</i> (Benth.) Benth.	0.33	12.50	2.60	0.208	5.86
13	<i>Elymus nutans</i> Griseb.	20.00	30.00	66.67	2.222	84.00
14	<i>Gentiana moorcroftiana</i> (Wall. ex Griseb.) Airy Shaw	0.15	7.50	2.00	0.267	3.32
15	<i>Geranium himalayense</i> Klotzsch	0.18	7.50	2.33	0.311	3.42

16	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	0.20	10.00	2.00	0.200	4.72
17	<i>Myosotis alpestris</i> F. W. Schmidt	0.58	10.00	5.75	0.575	6.22
18	<i>Nepeta podostachys</i> Benth.	0.58	10.00	5.75	0.575	5.87
19	<i>Oxytropis mollis</i> Benth.	0.15	7.50	2.00	0.267	3.61
20	<i>Plantago depressa</i> Willd.	0.15	10.00	1.50	0.150	4.26
21	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	0.18	7.50	2.33	0.311	3.57
22	<i>Erigeron poncinsii</i> (Franch.) Botsch.	0.20	10.00	2.00	0.200	7.65
23	<i>Rheum spiciforme</i> Royle	0.23	10.00	2.25	0.225	10.23
24	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.35	10.00	3.50	0.350	9.00
25	<i>Stipa</i> sp.	3.65	7.50	48.67	6.489	44.84
26	<i>Taraxacum officinale</i> Wigg.	0.33	15.00	2.17	0.144	6.63
27	<i>Thalictrum cultratum</i> Wall.	0.65	5.00	13.00	2.600	4.57
28	<i>Thermopsis inflata</i> Cambess.	0.70	7.50	9.33	1.244	6.46

**b) Altitude Range: > 4800 m**







A perusal of table 9 for shrubs at site -Dhinam showed that total number of shrubs species was 4. *Caragana versicolor* (222.74) was dominant species on the basis of IVI followed by *Krascheninnikovia ceratoides* (35.33) and least dominant was *Lonicera spinosa* (16.89). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (4.18) followed by *Krascheninnikovia ceratoides* (0.70) and lowest value (0.23) was observed for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (40.00) followed by *Krascheninnikovia ceratoides*. (17.50) and minimum value (10.00) was observed for *Lonicera spinosa*. Maximum abundance was observed for *Caragana versicolor* (10.44) followed by *Krascheninnikovia ceratoides* (4.00) and minimum value (2.25) was observed for *Lonicera spinosa*. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table 9). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.58, 0.84, 0.55 and 0.61, respectively at Dhinam.

**Table 9: Phytosociological attributes of shrubs in Dhinam at an altitudinal range > 4800 m.**

S.No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	4.18	40.00	10.44	0.261	222.74
2	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.70	17.50	4.00	0.229	35.33
3	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.23	10.00	2.25	0.225	16.89
4	<i>Potentilla arbuscula</i> D. Don	0.48	12.50	3.80	0.304	25.03

A perusal of table 10 for herbs at site - Dhinam showed that total number of herbs species was 14. *Elymus nutans* (69.66) was dominant species on the basis of IVI followed by *Stipa* sp. (45.44), *Carex* sp. (35.66) and least dominant was *Aconitum* sp. (5.45). *Elymus nutans* showed highest value for density/m<sup>2</sup> (6.40) followed by *Stipa* sp.. (3.08) and lowest value (0.10) was observed for *Saussurea glacialis*. Maximum frequency % was observed for *Carex* sp. (15.00) followed by *Berginia stracheyi* (10.00), *Elsholtzia eriostachya* (10.00), *Elymus nutans* (10.00), *Geranium himalayense* (10.00) and *Potentilla argyrophylla* (10.00) and minimum value (5.00) was observed for *Rhodiola heterodonta*. Maximum abundance was observed for *Elymus nutans* (64.00) followed by *Stipa* sp.. (41.00), *Carex* sp. (11.67) and minimum value (1.33) was observed for *Saussurea glacialis*. Contiguous distribution pattern was observed for all the herbs species at Dhinam (Table 10). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.12, 2.37, 2.04 and 0.90, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 6.18, 7.32 and 41.25, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.36, 112.26, 8.25 and 371.68, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high at Dhinam.



	
<p><i>Allium carolinianum</i> DC.</p>	<p><i>Cousinia thomsonii</i> C. B. Clarke</p>
	
<p><i>Rheum spiciforme</i> Royle</p>	<p><i>Lindelofia stylosa</i> (Kar. &amp; Kir.) Brand</p>
	
<p><i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.</p>	<p><i>Caragana versicolor</i> Benth.</p>

**Plate -5: Some plants of Kibber Wildlife Sanctuary**

**Table 10: Phytosociological attributes of herbs species in Dhinam at an altitudinal range >4800 m.**

S.No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconitum</i> sp.	0.13	5.00	2.50	0.500	5.45
2	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	0.85	10.00	8.50	0.850	19.31
3	<i>Carex</i> sp.	1.75	15.00	11.67	0.778	35.66
4	<i>Elsholtzia eriostachya</i> (Benth.) Benth.	0.80	10.00	8.00	0.800	16.15
5	<i>Elymus nutans</i> Griseb.	6.40	10.00	64.00	6.400	69.66
6	<i>Gentiana moorcroftiana</i> (Wall. ex Griseb.) Airy Shaw	0.20	7.50	2.67	0.356	8.64
7	<i>Geranium himalayense</i> Klotzsch	0.15	10.00	1.50	0.150	9.94
8	<i>Nepeta eriostachya</i> Benth	0.53	5.00	10.50	2.100	10.92
9	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	0.43	10.00	4.25	0.425	12.68
10	<i>Rheum spiciforme</i> Royle	0.18	7.50	2.33	0.311	23.25
11	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.13	5.00	2.50	0.500	11.26
12	<i>Saussurea glacialis</i> Herder.	0.10	7.50	1.33	0.178	8.29
13	<i>Saussurea nana</i> (Pamp.) Pamp.	0.15	7.50	2.00	0.267	23.33
14	<i>Stipa</i> sp.	3.08	7.50	41.00	5.467	45.44

### 3. Name of Site: Chichham-1

#### a) Altitude Range: < 4400 m

Phytosociological analysis of shrubs (Table 11) in Chichham-1 showed that five species of shrubs were recorded. *Caragan versicolor* (184.76) was dominant species followed by *Lonicera spinosa* (38.54) on the basis of IVI and least dominant was *Potentilla arbuscula* (17.26). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (4.95) followed by *Ephedra gerardiana* (1.63) and lowest value (0.38) was observed for *Potentilla arbuscula*. Maximum frequency



% was observed for *Caragana versicolor* (47.50) and minimum was observed (12.50) for *Ephedra gerardiana* and *Potentilla arbuscula*. Maximum abundance was observed for *Ephedra gerardiana* (13.00) followed by *Caragana versicolor* (10.42) and minimum (2.67) was observed for *Krascheninnikovia ceratoides*. The ratio of A/F for shrubs indicated that the distribution pattern of all the species was contiguous (Table 11). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 1.11, 1.13, 0.69 and 0.70, respectively at Chichham-1.

**Table 11: Phytosociological attributes of shrubs in Chichham-1 at an altitudinal range < 4400 m.**

S.No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	4.95	47.50	10.42	0.219	184.76
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.63	12.50	13.00	1.040	37.10
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.40	15.00	2.67	0.178	22.35
4	<i>Potentilla arbuscula</i> D. Don	0.38	12.50	3.00	0.240	17.26
5	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	1.20	15.00	8.00	0.533	38.54

Phytosociological analysis of herbs (Table 12) at Chichham-1 showed that total number of species of herbs was 14. *Elymus nutans* (55.42) was dominant species on the basis of IVI followed by *Allium carolinianum* (35.17) and least dominant was *Aconitum sp* (4.61). *Elymus nutans* showed highest value for density/m<sup>2</sup> (3.15) followed by *Berginia stracheyi* (0.70) and lowest value (0.13) was observed for *Aconitum sp.* and *Geranium himalayense*. Maximum frequency % was observed for *Elymus nutans* (25.00) followed by *Aconogonum tortuosum* (15.00) and minimum value (5.00) was observed for *Aconitum sp.*, *Gentiana tianschanica* and *Geranium himalayense*. Maximum abundance was observed for *Bistorta affinis* (13.00) followed by *Elymus nutans* (12.60), and minimum value (2.33) was observed for *Lindelofia stylosa*. The ratio of A/F for herbs indicated that the distribution pattern of all the species was contiguous (Table-12). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.09, 2.52, 2.19 and 0.95, respectively (Table-47). A perusal of (Table-48) showed that soil moisture (%), pH and electrical conductivity were 7.52, 7.80

and 43.25, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.46, 121.00, 8.23 and 349.56, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 12: Phytosociological attributes of herbs in Chichham-1 at an altitudinal range <4400 m.**

S.No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconitum</i> sp.	0.13	5.00	2.50	0.500	4.61
2	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	0.63	15.00	4.17	0.278	17.37
3	<i>Allium carolinianum</i> DC.	0.65	12.50	5.20	0.416	35.17
5	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	0.65	10.00	6.50	0.650	29.59
4	<i>Artemisia</i> sp.	0.40	10.00	4.00	0.400	11.14
6	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	0.70	10.00	7.00	0.700	28.32
7	<i>Bistorta affinis</i> (D.Don) Greene	0.65	5.00	13.00	2.600	24.63
8	<i>Christolea crassifolia</i> Cambess.	0.38	7.50	5.00	0.667	13.12
9	<i>Corydalis crassifolia</i> Royle	0.45	7.50	6.00	0.800	12.50
10	<i>Elymus nutans</i> Griseb.	3.15	25.00	12.60	0.504	55.42
15	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	0.18	5.00	3.50	0.700	11.77
11	<i>Geranium himalayense</i> Klotzsch	0.13	5.00	2.50	0.500	4.79
12	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	0.35	15.00	2.33	0.156	23.57
13	<i>Nepeta</i> sp.	0.43	12.50	3.40	0.272	13.44
14	<i>Potentilla</i> sp.	0.65	10.00	6.50	0.650	14.56

**b) Altitude Range: 4400 m-4800 m**

A perusal of table 13 for shrubs at Chichham-1 showed that total number of shrubs species was 7. *Caragana versicolor* (197.58) was dominant on the basis of IVI followed by *Potentilla arbuscula* (31.15) and least dominant was *Lonicera semenovii* (3.68). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (5.95) followed by *Potentilla arbuscula* (1.13) and lowest value (0.08) was observed for *Lonicera semenovii*. Maximum frequency % was observed for *Caragana versicolor* (47.50) followed *Krascheninnikovia ceratoides* (22.50) and minimum value (2.50) was observed for *Ribes orientale* and *Lonicera semenovii*. Maximum abundance was observed for *Caragana versicolor* (12.53) followed by *Potentilla arbuscula* (11.25) and minimum value (2.00) was observed for *Krascheninnikovia ceratoides*. Contiguous distribution pattern was observed for all the shrubs species at Chichham-1 (Table 13). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.46, 1.17, 1.02 and 0.24, respectively at Chichham-1. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 13: Phytosociological attributes of shrubs in Chichham-1 at an altitudinal range between 4400 m - 4800 m.**

S.No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	5.95	47.50	12.53	0.264	197.58
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.48	7.50	6.33	0.844	12.84
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.45	22.50	2.00	0.089	30.51
4	<i>Lonicera semenovii</i> Regel	0.08	2.50	3.00	1.200	3.68
5	<i>Potentilla arbuscula</i> D. Don	1.13	10.00	11.25	1.125	31.15
6	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.63	10.00	6.25	0.625	20.09
7	<i>Ribes orientale</i> Desf.	0.13	2.50	5.00	2.000	4.14

A perusal of table 14 for herbs at Chichham-1 showed that total number of herbs species was 20. *Elymus nutans* (57.66) was dominant species on the basis of IVI followed by *Allium carolinianum* (37.67) and least dominant was *Thymus linearis* (4.41). *Elymus nutans* showed highest value for density/m<sup>2</sup> (3.13) followed by *Paraquilegia microphylla* (0.63), *Berginia stracheyi* and *Carex* sp. (0.53) and lowest value (0.10) was observed for *Thymus linearis*. Maximum frequency % was observed (20.00) for *Allium carolinianum* and *Elymus nutans* followed by *Berginia stracheyi* (17.50) and minimum value (5.00) was observed for *Biebersteinia odora*, *Carex* sp., *Gentiana tianschanica*, *Geranium lambertii*, *Plantago depressa*, *Thermopsis inflata* and *Thymus linearis*. Maximum abundance was observed for *Elymus nutans* (15.63) followed by *Carex* sp. (10.50) and minimum value (2.00) was observed for *Astragalus rhizanthus* and *Thymus linearis*. Contiguous distribution pattern was observed for all the herbs species at Chichham-1 (Table 14). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.09, 2.71, 3.24 and 0.90, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.32, 7.77 and 39.28, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.47, 120.20, 7.12 and 354.00, respectively.

**Table 14: Phytosociological attributes of herbs species in Chichham-1 at an altitudinal range between 4400 m- 4800 m.**

S. No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Allium carolinianum</i> DC.	0.43	20.00	2.13	0.106	37.67
2	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	0.23	7.50	3.00	0.400	8.36
3	<i>Astragalus rhizanthus</i> Benth.	0.15	7.50	2.00	0.267	12.71
4	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	0.53	17.50	3.00	0.171	19.50
5	<i>Biebersteinia odora</i> Stephan ex Fisch.	0.15	5.00	3.00	0.600	5.57
6	<i>Carex</i> sp.	0.53	5.00	10.50	2.100	10.65
7	<i>Elymus nutans</i> Griseb.	3.13	20.00	15.63	0.781	57.66
8	<i>Eritrichium canum</i>	0.50	10.00	5.00	0.500	14.25

	(Benth.) Kitam.					
9	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	0.13	5.00	2.50	0.500	5.95
10	<i>Geranium lambertii</i> Sweet	0.15	5.00	3.00	0.600	5.14
11	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	0.23	7.50	3.00	0.400	16.36
12	<i>Paraquilegia microphylla</i> (Royle) J.R Drumm. & Hutch.	0.65	7.50	8.67	1.156	13.96
13	<i>Plantago depressa</i> Willd.	0.15	5.00	3.00	0.600	6.55
14	<i>Potentilla nivea</i> Linn.	0.20	7.50	2.67	0.356	8.37
15	<i>Potentilla</i> sp.	0.13	5.00	2.50	0.500	4.74
16	<i>Rheum spiciforme</i> Royle	0.35	10.00	3.50	0.350	26.41
17	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.38	7.50	5.00	0.667	23.93
18	<i>Rosularia alpestris</i> (Kar. & Kir.) Boriss.	0.28	7.50	3.67	0.489	9.24
19	<i>Thermopsis inflata</i> Cambess.	0.45	5.00	9.00	1.800	8.58
20	<i>Thymus linearis</i> Benth.	0.10	5.00	2.00	0.400	4.41

#### 4. Name of Site: Chichham-2

##### a) Altitude Range: 4400 m-4800 m

Phytosociological analysis of shrubs (Table 15) in Chichham-2 showed that 5 species of shrubs were recorded. *Caragana versicolor* (224.56) was dominant species followed by *Ephedra gerardiana* (41.91) on the basis of IVI and least dominant was *Potentilla arbuscula* (3.48). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (20.88) followed by *Ephedra gerardiana* (7.00) and lowest value (0.13) was observed for *Potentilla arbuscula*. Maximum frequency % was observed for *Caragana versicolor* (50.00) and minimum was observed (2.50) for *Lonicera spinosa* and *Potentilla arbuscula*. Maximum abundance was observed for *Ephedra gerardiana* (46.67) followed by *Caragana versicolor* (41.75) and minimum (4.75) was observed for *Krascheninnikovia ceratoides*. The ratio of A/F for shrubs indicated that the distribution pattern of all the species was contiguous (Table 15). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and

evenness index (E) for shrub was 1.05, 0.70, 0.57 and 0.43, respectively at Chichham-2.

**Table 15: Phytosociological attributes of shrubs in Chichham-2 at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	20.88	50.00	41.75	0.835	224.56
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	7.00	15.00	46.67	3.111	41.91
3	<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	0.95	20.00	4.75	0.238	25.65
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.30	2.50	12.00	4.800	4.39
5	<i>Potentilla arbuscula</i> D. Don	0.13	2.50	5.00	2.000	3.48

Phytosociological analysis of herbs table 16 at Chichham-2 showed that total number of species of herbs was 18. *Allium carolinianum* (69.44) was dominant species on the basis of IVI followed by *Elymus nutans* (65.47), *Cousinia thomsonii* (53.43) respectively and least dominant was *Thalictrum cultratum* (3.95). *Elymus nutans* showed highest value for density/m<sup>2</sup> (11.85) followed by *Allium carolinianum* (4.23), *Cousinia thomsonii* (1.18) and lowest value (0.15) was observed for *Rheum spiciforme*. Maximum frequency % was observed for *Allium carolinianum* and *Cousinia thomsonii* (50.00) followed by *Elymus nutans* (37.50), and minimum value (5.00) was observed for *Potentilla* sp. and *Thermopsis inflata*. Maximum abundance was observed for *Elymus nutans* (31.60) followed by *Rhodiola tibetica* (15.33), *Nepeta podostachys* (9.33) and minimum value (2.00) was observed for *Rheum spiciforme*. The ratio of A/F for herbs indicated that the distribution pattern of all the species was contiguous (Table-16). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.14, 2.33, 2.45 and 0.81, respectively (Table 47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.44, 7.67 and 44.21, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.48, 120.00, 9.21 and 355.26, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available

phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 16: Phytosociological attributes of herbs in Chichham-2 at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of Species	Density/m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	0.45	7.50	6.00	0.800	5.29
2	<i>Allium carolinianum</i> DC.	4.23	50.00	8.45	0.169	69.44
3	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	0.90	12.50	7.20	0.576	14.28
4	<i>Aster flaccidus</i> Bunge	0.40	7.50	5.33	0.711	5.21
5	<i>Astragalus rhizanthus</i> Benth.	0.98	12.50	7.80	0.624	11.63
6	<i>Berginia stracheyi</i> (Hook.f.Thomson) Engl.	0.40	7.50	5.33	0.711	7.10
7	<i>Cousinia thomsonii</i> C. B. Clarke	1.18	50.00	2.35	0.047	53.43
8	<i>Dracocephalum heterophyllum</i> Benth.	0.90	10.00	9.00	0.900	9.08
9	<i>Elymus nutans</i> Griseb.	11.85	37.50	31.60	0.843	65.47
10	<i>Geranium himalayense</i> Klotzsch	0.23	7.50	3.00	0.400	3.96
11	<i>Heracleum pinnatum</i> C.B. Clarke	0.55	10.00	5.50	0.550	7.05
12	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	0.58	7.50	7.67	1.022	9.72
13	<i>Nepeta</i> sp.	0.70	7.50	9.33	1.244	6.84
14	<i>Potentilla</i> sp.	0.33	5.00	6.50	1.300	4.50
15	<i>Rheum spiciforme</i> Royle	0.15	7.50	2.00	0.267	7.74
16	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	1.15	7.50	15.33	2.044	10.21
17	<i>Thalictrum cultratum</i> Wall.	0.20	7.50	2.67	0.356	3.95
18	<i>Thermopsis inflata</i> Cambess.	0.40	5.00	8.00	1.600	5.10

**b) Altitude Range: > 4800 m**

A perusal of table 17 for shrubs at Chichham-2 showed that total number of shrubs species was 3. *Caragana versicolor* (275.30) was dominant on the basis of IVI followed by *Ephedra gerardiana* (18.91) and least dominant was *Potentilla arbuscula* (5.79). *Caragana versicolor* showed highest value for

density/m<sup>2</sup> (10.88) followed by *Ephedra gerardiana* (0.73) and lowest value (0.15) was observed for *Potentilla arbuscula*. Maximum frequency % was observed for *Caragana versicolor* (50.00) followed *Ephedra gerardiana* (7.50) and minimum value (2.50) was observed for *Potentilla arbuscula*. Maximum abundance was observed for *Caragana versicolor* (21.75) followed by *Ephedra gerardiana* (9.67) and minimum value (6.00) was observed for *Potentilla arbuscula*. Contiguous distribution pattern was observed for all the shrubs species at Chichham-2 (Table 17). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.85, 0.33, 0.33 and 0.30, respectively at Chichham-2.

**Table 17: Phytosociological attributes of shrubs in Chichham-2 at an altitudinal range > 4800 m.**

S. No.	Name of Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	10.88	50.00	21.75	0.435	275.30
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.73	7.50	9.67	1.289	18.91
3	<i>Potentilla arbuscula</i> D. Don	0.15	2.50	6.00	2.400	5.79

A perusal of table 18 for herbs at Chichham-2 showed that total number of herbs species was 11. *Elymus nutans* (115.66) was dominant species on the basis of IVI followed by *Rhodiola tibetica* (59.72) and least dominant was *Geranium himalayense* (2.44). *Elymus nutans* showed highest value for density/m<sup>2</sup> (8.95) followed by *Rhodiola tibetica* (3.90), *Berginia stracheyi* and *Potentilla* sp. (1.23) and lowest value (0.05) was observed for *Astragalus rhizanthus* and *Geranium himalayense*. Maximum frequency % was observed for *Elymus nutans* (20.00) followed by *Aster flaccidus*, *Berginia stracheyi* and *Potentilla* (17.50) and minimum value (2.50) was observed for *Geranium himalayense*. Maximum abundance was observed for *Elymus nutans* (44.75) followed by *Rhodiola tibetica* (31.20), *Potentilla* (7.00) and minimum value (1.00) was observed for *Astragalus rhizanthus*. Contiguous distribution pattern was observed for all the herbs species at Chichham-2 (Table 18). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.22, 1.86, 1.53 and 0.78, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.48, 7.69 and 45.31, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.43, 121.25, 5.25 and 350.50, respectively. Organic



carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 18: Phytosociological attributes of herbs species in Chichham-2 at an altitudinal range > 4800 m.**

S. No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aster flaccidus</i> Bunge	0.65	17.50	3.71	0.212	21.49
2	<i>Astragalus rhizanthus</i> Benth.	0.05	5.00	1.00	0.200	4.70
3	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	1.23	17.50	7.00	0.400	35.03
4	<i>Corydalis crassifolia</i> Royle	0.30	5.00	6.00	1.200	6.74
5	<i>Elymus nutans</i> Griseb.	8.95	20.00	44.75	2.238	115.66
6	<i>Geranium himalayense</i> Klotzsch	0.05	2.50	2.00	0.800	2.44
7	<i>Heracleum pinnatum</i> C.B. Clarke	0.45	12.50	3.60	0.288	13.07
8	<i>Potentilla</i> sp.	1.23	17.50	7.00	0.400	22.37
9	<i>Rheum spiciforme</i> Royle	0.15	10.00	1.50	0.150	11.61
10	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	3.90	12.50	31.20	2.496	59.72
11	<i>Saussurea glacialis</i> Herder.	0.10	5.00	2.00	0.400	7.17

## 5. Name of Site: Gete

### a) Altitude Range: 4400 m-4800 m

A perusal of Table-19 for shrubs at site- Gete showed that total number of shrubs species was 5. *Caragana versicolor* (197.18) was dominant species on the basis of IVI followed by *Kraschenikovia ceratoides* (31.97), and least dominant was *Potentilla arbuscula* (18.56). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (4.70) followed by *Ephedra gerardiana* (1.13) and lowest value (0.65) was recorded for *Potentilla arbuscula*. Maximum frequency % was observed for *Caragana versicolor* (42.50) followed by *Lonicera spinosa* (17.50) and minimum value (10.00) was observed for *Potentilla arbuscula* and *Ephedra gerardiana*. Maximum abundance was observed for *Ephedra gerardiana* (11.25) followed by *Caragana versicolor* (11.06) and minimum value (4.43) was observed for *Lonicera spinosa*. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table 19). A perusal of (Table-47) showed that concentration of dominance (C), diversity index (H),

richness index (R) and evenness index (E) for shrub was 1.07, 1.05, 0.69 and 0.65, respectively at Gete.

**Table 19: Phytosociological attributes of shrubs in Gete at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	4.70	42.50	11.06	0.260	197.18
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.13	10.00	11.25	1.125	24.28
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst	1.05	15.00	7.00	0.467	31.97
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.78	17.50	4.43	0.253	28.01
5	<i>Potentilla arbuscula</i> D. Don	0.65	10.00	6.50	0.650	18.56

A perusal of Table-20 for herbs at site Gete showed that total number of herbs species was 22. *Elymus nutans* (55.87) was dominant species on the basis of IVI followed by *Carex* sp. (39.47) and least dominant was *Aconitum* sp. (1.77). *Elymus nutans* showed highest value for density/ m<sup>2</sup> (8.63) followed by *Carex* sp. (2.95) and lowest value (0.08) was observed for *Aconitum* sp. Maximum frequency % was observed for *Lindelofia stylosa* (22.50) followed by *Nepeta podostachys* (15.00) and minimum value was observed for was *Aconitum* sp. and *Arnebia euchroma* (2.50). Maximum abundance was observed for *Elymus nutans* (69.00) followed by *Carex* sp. (23.60), *Stipa* sp. (23.50) and minimum value (1.50) was observed for *Astragalus rhizanthus*. Contiguous distribution pattern was observed for all the herbs species at Gete (Table 20). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.10, 2.64, 3.14 and 0.85, respectively (Table-47). A perusal of (Table-48) showed that soil moisture (%), pH and electrical conductivity were 6.50, 7.78 and 43.20, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.45, 118.20, 4.21 and 344.70, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 20: Phytosociological attributes of herbs species in Gete at an altitudinal range between 4400m-4800 m.**

S.No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconitum</i> sp.	0.08	2.50	3.00	1.200	1.77
2	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	0.25	5.00	5.00	1.000	4.12
3	<i>Allium carolinianum</i> DC.	0.38	12.50	3.00	0.240	10.76
4	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	0.13	2.50	5.00	2.000	2.47
5	<i>Artemisia gmelinii</i> Web. ex Stechm.	0.23	5.00	4.50	0.900	3.90
6	<i>Astragalus</i> sp.	0.73	5.00	14.50	2.900	7.35
7	<i>Astragalus rhizanthus</i> Benth.	0.15	10.00	1.50	0.150	6.05
8	<i>Bergenia stracheyi</i> (Hook.f. & Thomson) Engl.	0.40	7.50	5.33	0.711	11.50
9	<i>Carex</i> sp.	2.95	12.50	23.60	1.888	39.47
10	<i>Corydalis crassifolia</i> Royle	0.58	7.50	7.67	1.022	8.38
11	<i>Cousinia thomsonii</i> C. B. Clarke	0.30	7.50	4.00	0.533	10.09
12	<i>Dracocephalum heterophyllum</i> Benth.	0.35	7.50	4.67	0.622	5.92
13	<i>Elymus nutans</i> Griseb.	8.63	12.50	69.00	5.520	55.87
14	<i>Geranium himalayense</i> Klotzsch	0.18	7.50	2.33	0.311	4.96
15	<i>Lindelofia stylosa</i> (Kar. & kir.) Brand	1.40	22.50	6.22	0.277	56.42
16	<i>Nepeta podostachys</i> Benth.	0.43	15.00	2.83	0.189	14.92
17	<i>Potentilla argyrophylla</i> Wall. ex Lehm..	0.53	7.50	7.00	0.933	12.33
18	<i>Potentilla bifurca</i> Linn.	0.35	12.50	2.80	0.224	10.48
19	<i>Stipa</i> sp.	1.18	5.00	23.50	4.700	11.69
20	<i>Taraxacum officinale</i> Wigg.	0.20	7.50	2.67	0.356	7.14

21	<i>Thalictrum foetidum</i> Linn.	0.33	7.50	4.33	0.578	5.61
22	<i>Thermopsis inflata</i> Cambess.	0.48	7.50	6.33	0.844	8.77

**b) Altitude Range: >4800 m**

A perusal of Table 21 for shrubs at site Gete showed that total number of herbs species was 5. *Caragana versicolor* (227.27) was dominant species on the basis of IVI followed by *Lonicera spinosa* (20.85), and least dominant was *Potentilla arbuscula* (14.98). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (3.35) followed by *Lonicera spinosa* (0.65) and lowest value (0.13) was observed for *Ephedra gerardiana*. Maximum frequency % was observed for *Caragana versicolor* (42.50) followed by *Ephedra gerardiana* (10.00) and *Krascheninnikovia ceratoides* (10.00) and minimum value (5.00) was observed for *Lonicera spinosa*. Maximum abundance was observed for *Lonicera spinosa* (13.00) followed *Caragana versicolor*. (7.88) and minimum value (1.25) was observed for *Ephedra gerardiana*. Contiguous distribution pattern was observed for all the shrubs species at Gete (Table 21). A perusal of (Table-47) showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 0.59, 0.89, 0.76 and 0.55, respectively at Gete.

**Table 21: Phytosociological attributes of shrubs in Gete at an altitudinal range > 4800 m.**

S.No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	3.35	42.50	7.88	0.185	227.27
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.13	10.00	1.25	0.125	16.06
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst	0.33	10.00	3.25	0.325	20.84
4	<i>Lonicera spinosa</i> (Jacq. ex Decne.) Walp.	0.65	5.00	13.00	2.600	20.85
5	<i>Potentilla arbuscula</i> D. Don	0.23	7.50	3.00	0.400	14.98

A perusal of (Table- 22) for herbs at site-Gete showed that total number of herb species was 16. *Lindelofia stylosa* (70.22) was dominant species on the basis of IVI followed by *Carex* sp. (64.96) and least dominant was *Aconitum* sp. (1.71). *Lindelofia stylosa* showed highest value for density/m<sup>2</sup> (5.25) followed by *Carex* sp. (5.05) and lowest value (0.08) was observed for *Aconitum* sp. Maximum frequency % was observed for *Lindelofia stylosa* (45.00) followed by *Carex* sp.

(30.00) and minimum value (2.50) was observed for *Aconitum* sp., *Rhodiola heterodonta*. Maximum abundance was observed for *Astragalus rhizanthus* (20.40) followed by *Carex* sp. (16.83) and minimum value (3.00) was observed for *Aconitum* sp. Contiguous distribution pattern was observed for all the herbs species at Gete (Table 22). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.14, 2.28, 2.23 and 0.82, respectively (Table-47). A perusal of (Table-48) showed that soil moisture (%), and electrical conductivity were 6.20, 7.65 and 38.26, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.44, 115.23, 6.55 and 341.56, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 22: Phytosociological attributes of herbs species Gete an altitudinal range > 4800 m.**

S.No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconitum</i> sp.	0.08	2.50	3.00	1.200	1.71
2	<i>Allium carolinianum</i> DC.	2.40	20.00	12.00	0.600	31.82
3	<i>Astragalus</i> sp.	0.15	2.50	6.00	2.400	3.16
4	<i>Astragalus rhizanthus</i> Benth.	2.55	12.50	20.40	1.632	22.14
5	<i>Bergenia stracheyi</i> (Hook.f. &Thomson) Engl.	0.20	5.00	4.00	0.800	6.27
6	<i>Carex</i> sp.	5.05	30.00	16.83	0.561	64.96
7	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	0.20	5.00	4.00	0.800	4.17
8	<i>Geranium himalayense</i> Klotzsch	0.78	12.50	6.20	0.496	12.21
9	<i>Lindelofia stylosa</i> (Kar. & kir.) Brand	5.25	45.00	11.67	0.259	70.22
10	<i>Nepeta podostachys</i> Benth.	2.00	27.50	7.27	0.264	26.43
11	<i>Plantago</i> sp.	0.38	7.50	5.00	0.667	6.88
12	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	0.23	5.00	4.50	0.900	4.38
13	<i>Rheum spiciforme</i> Royle	0.23	5.00	4.50	0.900	6.74
14	<i>Rhodiola heterodonta</i>	0.30	2.50	12.00	4.800	9.26

	(Hook. f. & Th.) Boriss					
15	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	0.60	12.50	4.80	0.384	24.44
16	<i>Saussurea nana</i> (Pamp.) Pamp.	0.18	5.00	3.50	0.700	5.22

**6. Name of Site: Ladarcha**

**a) Altitude Range: 4400 m-4800 m**

A perusal of table 23 for shrubs at site-Ladarcha showed that total number of species of shrubs was 5. *Caragana versicolor* (232.72) was dominant species on the basis of IVI followed by *Lonicera spinosa* (23.28), *Ephedra gerardiana* (20.39) and least dominant was *Rhamnus prostrata* (8.24). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (5.05) followed by *Ephedra gerardiana* (0.60) and lowest value (0.08) was recorded for *Rhamnus prostrata*. Maximum frequency % was observed for *Caragana versicolor* (45.00) followed by *Ephedra gerardiana*, *Krascheninnikovia ceratoides* and *Lonicera spinosa* (7.50) and minimum value (5.00) was observed for *Rhamnus prostrata*. Maximum abundance was observed for *Caragana versicolor* (11.22) followed by *Ephedra gerardiana* (8.00) and minimum value (1.50) was observed for *Rhamnus prostrata*. The ratio of A/F indicated that the distribution pattern of all the species was contiguous for shrubs at Ladarcha (Table 23). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 1.06, 0.82, 0.56 and 0.51, respectively at Ladarcha.

**Table 23: Phytosociological attributes of shrubs in Ladarcha at an altitudinal range between 4400 m-4800 m.**

S.No.	Name of Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	5.05	45.00	11.22	0.249	232.72
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.60	7.50	8.00	1.067	20.39
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.30	7.50	4.00	0.533	15.37
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.58	7.50	7.67	1.022	23.28
5	<i>Rhamnus prostrata</i> Jacq. ex Parker	0.08	5.00	1.50	0.300	8.24

A perusal of Table-24 for herbs at site-Ladarcha showed that total number of species of herbs was 19. *Bergenia stracheyii* (81.88) was dominant species on the basis of IVI followed by *Allium carolinianum* (37.48), *Rhodiola tibetica* (36.56) and least dominant was *Potentilla desertorum* (2.31). *Rhodiola tibetica* showed highest value for density/m<sup>2</sup> (9.78) followed by *Allium carolinianum* (6.80) and lowest value (0.10) was observed for *Potentilla desertorum*. Maximum frequency % was observed for *Allium carolinianum* (40.00) followed by *Arnebia euchroma* (30.00), *Potentilla bifurca* (30.00), *Rhodiola crenulata* (27.50) and minimum value (2.50) was observed for *Nepeta eriostachya* and *Rhodiola wallichiana*. Maximum abundance was observed for *Rhodiola wallichiana* (48.00) followed by *Nepeta eriostachya* (45.00), *Rhodiola tibetica* (43.44) and minimum was *Cousinia thomsonii* and *Potentilla desertorum*. (2.00). The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table-24). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.14, 2.28, 2.06 and 0.82, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.98, 7.81 and 69.32, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.78, 140.21, 9.15 and 362.16, respectively. Organic carbon (%) was recorded medium. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 24: Phytosociological attributes of herbs species in Ladarcha at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Allium carolinianum</i> DC.	6.80	40.00	17.00	0.425	37.48
2	<i>Arnebia euchroma</i> (Royle ex Benth.) I. M. Johnston	4.28	30.00	14.25	0.475	26.65
3	<i>Artemisia salsoloides</i> Willd.	0.28	7.50	3.67	0.489	3.94
4	<i>Astragalus rhizanthus</i> Benth.	1.55	17.50	8.86	0.506	11.65
5	<i>Bergenia stracheyi</i> (Hook.f.&Thomson) Engl.	3.13	20.00	15.63	0.781	81.88
6	<i>Cousinia thomsonii</i> C. B. Clarke	0.10	5.00	2.00	0.400	2.61
7	<i>Heracleum pinnatum</i> C.B. Clarke	0.50	5.00	10.00	2.000	3.48

8	<i>Kobresia royleana</i> (Nees) Boeckeler	3.13	7.50	41.67	5.556	13.00
9	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	1.48	7.50	19.67	2.622	17.56
10	<i>Nepeta eriostachya</i> Benth.	1.13	2.50	45.00	18.000	4.08
11	<i>Paraquilegia microphylla</i> (Royle) J.R Drumm. & Hutch.	0.33	5.00	6.50	1.300	2.81
12	<i>Potentilla bifurca</i> Linn.	2.05	30.00	6.83	0.228	17.01
13	<i>Potentilla desertorum</i> Bunge	0.10	5.00	2.00	0.400	2.31
14	<i>Potentilla</i> sp.	0.23	7.50	3.00	0.400	3.50
15	<i>Erigeron poncinsii</i> (Franch.) Botsch.	1.38	12.50	11.00	0.880	10.76
16	<i>Rhodiola crenulata</i> (Hook. f. Thomson) & Ohba	1.60	27.50	5.82	0.212	15.76
17	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.63	5.00	12.50	2.500	4.03
18	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	9.78	22.50	43.44	1.931	36.56
19	<i>Rhodiola wallichiana</i> (Hook.) S.H. Fu	1.20	2.50	48.00	19.200	4.93

**b) Altitude Range: >4800 m**







A perusal of table 25 for shrubs at site -Ladarcha showed that total number of shrubs species was 2. *Caragana versicolor* (268.25) was dominant species on the basis of IVI and least dominant was *Lonicera spinosa* (31.75). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (3.43) and lowest value (0.30) was observed for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (40.00) and minimum value (10.00) was observed for *Lonicera spinosa*. Maximum abundance was observed for *Caragana versicolor* (8.56) and minimum value (3.00) was observed for *Lonicera spinosa*. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table 25). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.90, 0.20, 0.16 and 0.29, respectively at Ladarcha.

**Table 25: Phytosociological attributes of shrubs in Ladarcha at an altitudinal range > 4800 m.**



S.No.	Name of Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	3.43	40.00	8.56	0.214	268.25
2	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.30	10.00	3.00	0.300	31.75

A perusal of table 26 for herbs at site - Ladarcha showed that total number of herbs species was 11. *Calamogrostis* sp. (115.74) was dominant species on the basis of IVI followed by *Berginia stracheyi* (48.34), *Rheum tibeticum* (39.04) and least dominant was *Christolea himalayensis* (1.97). *Calamogrostis* sp. showed highest value for density/m<sup>2</sup> (40.00) followed by *Elymus nutans* (6.13), *Rheum tibeticum* (4.00), and lowest value (0.05) was observed for *Christolea himalayensis*. Maximum frequency % was observed for *Calamogrostis* sp. (30.00) followed by *Elymus nutans* (20.00), *Androsace delavayi* (15.00) and *Rheum tibeticum* (15.00) and minimum value ((2.50) was observed for *Christolea himalayensis*. Maximum abundance was observed for *Calamogrostis* sp. (133.33) followed by *Elymus nutans* (30.63), *Rheum tibeticum* (26.67) and minimum value (2.00) was observed for *Christolea himalayensis* and *Rheum speciforme*. Contiguous distribution pattern was observed for all the herbs species at Ladarcha (Table 26). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.25, 1.74, 1.06 and 0.79, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 8.01, 7.83, and 69.56, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.61, 141.00, 6.18 and 366.00, respectively. Organic carbon (%) was recorded medium. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

	
<b><i>Aconogonum tortuosum</i> (D. Don) H. Hara</b>	<b><i>Astragalus rhizanthus</i> Royle ex. Benth.</b>
	
<b><i>Bergenia stracheyi</i> (Hook.f. &amp; Thomson) Engl</b>	<b><i>Dracocephalum heterophyllum</i> Benth.</b>
	
<b><i>Lonicera spinosa</i> (Jacq. Ex Decne.) Walp.</b>	<b><i>Potentilla arbuscula</i> D. Don</b>

**Plate -6: Some plants of Kibber Wildlife Sanctuary**

**Table 26: Phytosociological attributes of herbs species in Ladarcha at an altitudinal range > 4800 m.**

S. No.	Name of species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Androsace delavayi</i> Franch.	1.13	15.00	7.50	0.500	13.73
2	<i>Berginia stracheyi</i> (Hook.f.&Thomson) Engl.	1.05	12.50	8.40	0.672	48.34
3	<i>Calamagrostis</i> sp.	40.00	30.00	133.33	4.444	115.74
4	<i>Christolea himalayensis</i> (Cambess.) Jafri	0.05	2.50	2.00	0.800	1.97
5	<i>Elymus nutans</i> Griseb.	6.13	20.00	30.63	1.531	27.08
6	<i>Gagea lutea</i> (L.) Ker Gawl.	0.23	7.50	3.00	0.400	5.90
7	<i>Paraquilegia microphylla</i> (Royle) J.R Drumm. & Hutch.	0.70	10.00	7.00	0.700	8.51
8	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	1.03	12.50	8.20	0.656	10.95
9	<i>Rheum speciforme</i> Royle	0.15	7.50	2.00	0.267	9.57
10	<i>Rheum tibeticum</i> Maxim. ex Hook. f.	4.00	15.00	26.67	1.778	39.04
11	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.38	10.00	3.75	0.375	19.16

**7. Name of Site: Racholakmo**

**a) Altitude Range: 4400 m-4800 m**

A perusal of table-27 for shrubs at site- Racholakmo showed that total number of shrubs species was 5. *Caragana versicolor* (231.61) was dominant species on the basis of IVI followed by *Krascheninnikovia ceratoides* (24.83), and least dominant was *Myricaria germanica* (7.78). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (6.03) followed by *Lonicera spinosa* (0.95) and lowest value (0.15) was recorded for *Myricaria germanica*. Maximum frequency % was observed for *Caragana versicolor* (50.00) followed by *Krascheninnikovia ceratoides* (15.00), *Lonicera spinosa* (10.00) and minimum value (5.00) was observed for *Myricaria germanica* and *Ephedra gerardiana*. Maximum abundance was observed for *Caragana versicolor* (12.05) followed by *Lonicera spinosa* (9.50) and minimum value (3.00) was observed for

*Myricaria germanica*.. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table 27). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.61, 0.83, 0.69 and 0.52 respectively at Racholakmo.

**Table 27: Phytosociological attributes of shrubs in Racholakmo at an altitudinal range between 4400 m-4800 m.**

S.No.	Name of species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	6.03	50.00	12.05	0.241	231.61
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.38	5.00	7.50	1.500	11.01
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.48	15.00	3.17	0.211	24.83
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.95	10.00	9.50	0.950	24.77
5	<i>Myricaria germanica</i> (L.) Desv.	0.15	5.00	3.00	0.600	7.78

A perusal of table-28 for herbs at site Racholakmo showed that total number of herbs species was 7. *Elymus nutans* (87.19) was dominant species on the basis of IVI followed by *Tanacetum nubigenum* (65.79), *Christolea crassifolia* (44.01) and least dominant was *Physochlaina praealta* (15.24). *Elymus nutans* showed highest value for density/ m<sup>2</sup> (6.18) followed by *Tanacetum nubigenum* (1.78) and *Christolea crassifolia* (1.30) and lowest value (0.30) was observed for *Physochlaina praealta*. Maximum frequency % was observed for *Tanacetum nubigenum* (35.00) followed by *Elymus nutans* (30.00) and minimum value (2.50) was observed for *Physochlaina praealta*. Maximum abundance was observed for *Elymus nutans* (20.58) followed by *Physochlaina praealta* (12.00), *Askellia flexuosa* (6.60) and minimum value (3.83) was observed for *Alyssum desertorum*. Contiguous distribution pattern was observed for all the herbs species at Racholakmo (Table 28). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.19, 1.81, 0.97 and 0.93, respectively (Table 47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 6.82, 7.20 and 65.14, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available

potassium (Kg/ha) were 0.41, 105.16, 10.80 and 367.90, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 28: Phytosociological attributes of herbs species in Racholakmo at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of Species	Density / m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Alyssum desertorum</i> Stapf	0.58	15.00	3.83	0.256	31.87
2	<i>Askellia flexuosa</i> (Ledeb.) W. A. Weber	0.83	12.50	6.60	0.528	26.87
3	<i>Christolea crassifolia</i> Cambess.	1.30	20.00	6.50	0.325	44.01
4	<i>Elymus nutans</i> Griseb.	6.18	30.00	20.58	0.686	87.19
5	<i>Oxytropis microphylla</i> (Pall.) DC.	1.18	20.00	5.88	0.294	29.02
6	<i>Physochlaina praealta</i> (Walp.) Miers.	0.30	2.50	12.00	4.800	15.24
7	<i>Tanacetum nubigenum</i> Wall. ex DC.	1.78	35.00	5.07	0.145	65.79

**8. Name of Site: Gipsian Lumpa**

**a) Altitude Range: 4400 m-4800 m**

A perusal of Table-29 for shrubs at site- Gipsian Lumpa showed that total number of shrubs species was 4. *Caragana versicolor* (243.97) was dominant species on the basis of IVI followed by *Ephedra gerardiana* (32.79) and least dominant was *Myrcaria germanica* (4.41). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (10.30) followed by *Ephedra gerardiana* (1.88) and lowest value (0.13) was recorded for *Myrcaria germanica*. Maximum frequency % was observed for *Caragana versicolor* (50.00) followed by *Krascheninnikovia ceratoides* (15.00) and minimum value (2.50) was observed for *Myrcaria germanica*. Maximum abundance was observed for *Caragana versicolor* (20.60) followed by *Ephedra gerardiana* (15.00) and minimum value (2.67) was observed for *Krascheninnikovia ceratoides*. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table 29). A perusal of table- 47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.68, 0.61, 0.48 and 0.44, respectively at Gipsian Lumpa.

**Table 29: Phytosociological attributes of shrubs in Gipsian Lumpa at an altitudinal range between 4400 m-4800 m.**

S.No.	Name of Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	10.30	50.00	20.60	0.412	243.97
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.88	12.50	15.00	1.200	32.79
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.40	15.00	2.67	0.178	23.23
4	<i>Myricaria germanica</i> (L.) Desv.	0.13	2.50	5.00	2.000	4.41

A perusal of table-30 for herbs at site Gipsian Lumpa showed that total number of herbs species was 11. *Artemisia salsoloides* (87.70) was dominant species on the basis of IVI followed by *Elymus nutans* (59.81) and least dominant was *Rheum speciforme* (9.05). *Elymus nutans* showed highest value for density/ m<sup>2</sup> (8.00) followed by *Rhodiola tibetica* (3.13) and lowest value (0.18) was observed for *Rheum speciforme*. Maximum frequency % was observed for *Elymus nutans* (22.50) followed by *Artemisia salsoloides* (20.00), *Christolea crassifolia* (20.00) and *Tanacetum nubigenum* (20.00). And minimum value (7.50) was observed for *Alyssum desertorum*, *Dracocephalum heterophyllum*, *Euphorbia tibetica*, *Rheum speciforme* and *Rhodiola tibetica*. Maximum abundance was observed for *Rhodiola tibetica*. (41.67), followed by *Elymus nutans* (35.56) and *Euphorbia tibetica* (24.00) and minimum value (2.00) was observed for *Tanacetum nubigenum*. Contiguous distribution pattern was observed for all the herbs species at Gipsian Lumpa (Table 30). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.16, 2.10, 1.49 and 0.88, respectively (Table 47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 4.91, 7.10, and 62.31, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.21, 107.23, 8.95 and 390.00, respectively. Organic carbon (%) was recorded very low. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 30: Phytosociological attributes of herbs species in Gipsian Lumpa at an altitudinal range between 4400 m-4800 m.**

S. No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Alyssum desertorum</i> Stapf	1.08	7.50	14.33	1.911	15.72
2	<i>Artemisia salsoloides</i> Willd.	2.98	20.00	14.88	0.744	87.70
3	<i>Ascellia flexuosa</i> (Ledeb.) W. A. Weber	0.58	15.00	3.83	0.256	13.64
4	<i>Christolea crassifolia</i> Cambess.	0.95	20.00	4.75	0.238	19.60
5	<i>Dracocephalum</i> <i>heterophyllum</i> Benth.	0.63	7.50	8.33	1.111	10.03
6	<i>Elymus nutans</i> Griseb.	8.00	22.50	35.56	1.580	59.81
7	<i>Euphorbia tibetica</i> Boiss.	1.80	7.50	24.00	3.200	16.41
8	<i>Oxytropis microphylla</i> (Pall.) DC.	0.45	15.00	3.00	0.200	13.71
9	<i>Rheum spiciforme</i> Royle	0.18	7.50	2.33	0.311	9.05
10	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	3.13	7.50	41.67	5.556	36.16
11	<i>Tanacetum nubigenum</i> Wall. ex DC.	0.40	20.00	2.00	0.100	18.16

**9. Name of Site: Chumik Shaltery**

**a) Altitude Range: 4400 m-4800 m**

A perusal of table- 31 for shrubs at site- Chumik Shaltery showed that total number of species of shrubs was 3. *Caragana versicolor* (212.89) was dominant species on the basis of IVI followed by *Krascheninnikovia ceratoides* (57.94) and least dominant was *Ephedra gerardiana* (29.17). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (6.18) followed by *Ephedra gerardiana* (1.70) and lowest value (1.63) was recorded for *Krascheninnikovia ceratoides*. Maximum frequency % was observed for *Caragana versicolor* (50.00) followed by *Krascheninnikovia ceratoides* (25.00) and minimum value (5.00) was observed for *Ephedra gerardiana*. Maximum abundance was observed for *Ephedra gerardiana* (34.00) followed by *Caragana versicolor* (12.35) and minimum value (6.50) was observed for *Krascheninnikovia ceratoides*. The



ratio of A/F indicated that the distribution pattern of all the species was contiguous for shrubs at Chumik Shaltery (Table-31). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 0.55, 0.79, 0.34 and 0.72, respectively at Chumik Shaltery.

**Table 31: Phytosociological attributes of shrubs in Chumik Shaltery at an altitudinal range between 4400 m-4800 m.**

S.No.	Name of Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	6.18	50.00	12.35	24.700	212.89
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.70	5.00	34.00	680.000	29.17
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	1.63	25.00	6.50	26.000	57.94

A perusal of table-32 for herbs at site- Chumik Shaltery showed that total number of species of herbs was 17. *Elymus nutans* (74.98) was dominant species on the basis of IVI followed by *Artemisia santolinifolia* (51.97) and least dominant was *Nepeta eriostachya* (2.99). *Elymus nutans* showed highest value for density/m<sup>2</sup> (4.63) followed by *Artemisia santolinifolia* (0.98) and lowest value (0.05) was observed for *Lactuca tatarica*. Maximum frequency % was observed for *Elymus nutans* (20.00) followed by *Salsola collina* (17.50), *Oxytropis cachemiriana* (15.00) and minimum value (2.50) was observed for *Dracocephalum* sp. and *Nepeta eriostachya*. Maximum abundance was observed for *Elymus nutans* (23.13) followed by *Aconogonum tortuosum* (13.00) and *Dracocephalum stameinum* (13.00) and minimum was *Lactuca tatarica* (1.00). The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table-32). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.23, 1.74, 2.62 and 0.61, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 9.10, 6.90, and 61.21, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.45, 108.54, 7.36 and 348.00, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.



**Table 32: Phytosociological attributes of herbs species in Chumik Shalthey at an altitudinal range between 4400 m-4800 m.**

S.No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	0.65	5.00	13.00	2.600	12.23
2	<i>Alyssum desertorum</i> Stapf	0.40	10.00	4.00	0.400	12.17
3	<i>Artemisia santolinifolia</i> Turcz ex Krasch.	0.98	12.50	7.80	0.624	51.97
4	<i>Askellia flexuosa</i> (Ledeb.) W. A. Weber	0.33	7.50	4.33	0.578	9.48
5	<i>Chenopodium glaucum</i> Linn.	0.90	7.50	12.00	1.600	18.54
6	<i>Christolea crassifolia</i> Cambess.	0.38	10.00	3.75	0.375	11.49
7	<i>Dracocephalum</i> sp.	0.33	2.50	13.00	5.200	5.84
8	<i>Elymus nutans</i> Griseb.	4.63	20.00	23.13	1.156	74.98
9	<i>Geranium himalayense</i> Klotzsch	0.13	5.00	2.50	0.500	4.53
10	<i>Lactuca tatarica</i> (L.) C.A.Mey.	0.05	5.00	1.00	0.200	4.25
11	<i>Lepidium apetalum</i> Wild.	0.90	7.50	12.00	1.600	16.92
12	<i>Nepeta eriostachya</i> Benth	0.13	2.50	5.00	2.000	2.99
13	<i>Oxytropis cachemiriana</i> Cambess.	0.40	15.00	2.67	0.178	21.90
14	<i>Oxytropis microphylla</i> (Pall.) DC.	0.20	10.00	2.00	0.200	10.53
15	<i>Potentilla multifida</i> L.	0.30	12.50	2.40	0.192	13.62
16	<i>Salsola collina</i> Pall.	0.45	17.50	2.57	0.147	22.75
17	<i>Tanacetum nubigenum</i> Wall. ex DC.	0.15	5.00	3.00	0.600	5.83

**b) Altitude Range: >4800 m**

A perusal of table-33 for shrubs at site - Chumik Shalthey showed that total number of shrubs species was 3. *Caragana versicolor* (197.90) was dominant species on the basis of IVI followed by *Ephedra gerardiana* (61.99) and least dominant was *Krascheninnikovia ceratoides* (40.11). *Caragana versicolor*

showed highest value for density/m<sup>2</sup> (3.13) followed by *Ephedra gerardiana* (1.13) and lowest value (0.43) was observed for *Krascheninnikovia ceratoides*. Maximum frequency % was observed for *Caragana versicolor* (50.00) followed by *Krascheninnikovia ceratoides* (12.50) and minimum value (7.50) was observed for *Ephedra gerardiana*. Maximum abundance was observed for *Ephedra gerardiana* (15.00) followed by *Caragana versicolor* (6.25) and minimum value (3.40) was observed for *Krascheninnikovia ceratoides*. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table- 33). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.50, 0.87, 0.38 and 0.79, respectively at Chumik Shaltery.

**Table 33: Phytosociological attributes of shrubs in Chumik Shaltery at an altitudinal range > 4800 m.**

S.No.	Name of species	Density / 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	3.13	50.00	6.25	0.125	197.90
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.13	7.50	15.00	2.000	61.99
3	<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	0.43	12.50	3.40	0.272	40.11

A perusal of table- 34 for herbs at site - Chumik Shaltery showed that total number of herbs species was 7. *Rhodiola tibetica* (111.78) was dominant species on the basis of IVI followed by *Elymus nutans* (99.23) and *Elsholtzia eriostachya* (38.04) and least dominant was *Paraquilegia microphylla* (9.22). *Elymus nutans* showed highest value for density/m<sup>2</sup> (7.13) followed by *Rhodiola tibetica* (4.65) and *Elsholtzia eriostachya* (2.00) and lowest value (0.30) was observed for *Paraquilegia microphylla*. Maximum frequency % was observed for *Elymus nutans* (32.50) followed by *Rhodiola tibetica* (30.00) and minimum value (7.50) was observed for *Elsholtzia eriostachya*, *Silene nigrescens* and *Potentilla argrophylla*. Maximum abundance was observed for *Elymus nutans* (21.92) followed by *Elsholtzia eriostachya* (16.00) and minimum value (4.00) was observed for *Elsholtzia eriostachya* and *Silene nigrescens*. Contiguous distribution pattern was observed for all the herbs species at Chumik Shaltery (Table-34). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.27, 1.52, 0.93 and 0.78, respectively (Table-

47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 8.90, 7.01 and 59.23, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.37, 107.10, 5.40 and 340.90, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table 34: Phytosociological attributes of herbs species in Chumik Shalkey at an altitudinal range > 4800m.**

S. No.	Name of Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Elsholtzia eriostachya</i> (Benth.) Benth.	2.00	12.50	16.00	1.280	38.04
2	<i>Elymus nutans</i> Griseb.	7.13	32.50	21.92	0.675	99.23
3	<i>Paraquilegia microphylla</i> (Royle) J.R Drumm. & Hutch.	0.30	7.50	4.00	0.533	9.22
4	<i>Potentilla argrophylla</i> Wall. ex Lehm.	0.45	7.50	6.00	0.800	10.41
5	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	4.65	30.00	15.50	0.517	111.78
6	<i>Silene nigrescens</i> (Edgew.) Majumdar	0.40	7.50	5.33	0.711	10.63
7	<i>Saussurea nana</i> (Pamp.) Pamp.	0.40	10.00	4.00	0.400	20.69

**10. Name of Site: Langza (Langza beat)**

**a) Altitude Range: 4400 m-4800 m**

A perusal of table-35 for shrubs at site- Langza showed that total number of shrubs species was 5. *Caragana versicolor* (179.53) was dominant species on the basis of IVI followed by *Krascheninnikovia ceratoides* (40.11) and *Lonicera spinosa* (37.29) and least dominant was *Potentilla arbuscula* (14.16). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (4.70) followed by *Ephedra gerardiana* (1.13) and *Krascheninnikovia ceratoides* (0.90) and lowest value (0.35) was recorded for *Potentilla arbuscula*. Maximum frequency % was observed for *Caragana versicolor* (40.00) followed by *Krascheninnikovia ceratoides* (25.00) and *Lonicera spinosa* (20.00) and minimum value (7.50) was observed for *Ephedra gerardiana* and *Potentilla arbuscula*. Maximum abundance was observed for *Ephedra gerardiana* (15.00) followed by

*Caragana versicolor* (11.75) and *Potentilla arbuscula* (4.67) and minimum value (3.60) was observed for *Krascheninnikovia ceratoides*. Contiguous distribution pattern was observed for all shrubs at Langza (Table 35). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 1.13, 1.16, 0.69 and 0.72, respectively at Langza.

**Table-35: Phytosociological attributes of shrubs in Langza at an altitudinal range between 4400 m-4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	4.70	40	11.75	0.294	179.53
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.13	7.50	15.00	2.000	28.91
3	<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	0.90	25.00	3.60	0.144	40.11
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.85	20.00	4.25	0.213	37.29
5	<i>Potentilla arbuscula</i> D. Don	0.35	7.50	4.67	0.622	14.16

A perusal of table-36 for herbs at site Langza showed that total number of herbs species was 20. *Elymus nutans* (45.44) was dominant species on the basis of IVI followed by *Allium carolinianum* (38.79) and *Aconogonum tortuosum* (27.36) and least dominant was *Potentilla bifurca* (2.89). *Elymus nutans* showed highest value for density/ m<sup>2</sup> (5.58) followed by *Scrophularia dentata* (1.68) and *Aconogonum tortuosum* (1.63) and lowest value (0.10) was observed for *Potentilla bifurca* (0.13). Maximum frequency % was observed for *Elymus nutans* (20.00) followed by 17.50 for *Allium carolinianum*, *Lindelofia stylosa* and *Thermopsis inflata*. Minimum frequency % (5.00) was *Astragalus candolleanus*, *Potentilla bifurca* and *Thalictrum cultratum*. Maximum abundance was observed for *Elymus nutans* (27.88) followed by *Scrophularia dentata* (11.17) and *Aconogonum tortuosum* (10.83) and minimum value (1.67) were observed for *Allium carolinianum*. Contiguous distribution pattern was observed for all the herbs species at Langza (Table 36). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.08, 2.74, 2.76 and 0.91, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical

conductivity were 11.32, 6.95 and 45.44, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.58, 139.00, 6.18 and 261.00, respectively. Organic carbon (%) and available phosphorus (Kg/ha) were recorded low. Available nitrogen (Kg/ha) and available potassium (Kg/ha) was medium in the study site.

**Table-36: Phytosociological attributes of herbs species in Langza at an altitudinal range between 4400 m-4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	1.63	15.00	10.83	0.722	27.36
2	<i>Allium carolinianum</i> DC.	0.88	17.50	5.00	0.286	38.79
3	<i>Allium consanguineum</i> Kunth	0.13	7.50	1.67	0.222	4.77
4	<i>Arabidopsis himalaica</i> (Edgew.) O. E. Schulz	0.40	10.00	4.00	0.400	8.10
5	<i>Astragalus candolleanus</i> Royle ex Benth.	0.15	5.00	3.00	0.600	12.60
6	<i>Astragalus rhizanthus</i> Benth.	0.20	7.50	2.67	0.356	4.72
7	<i>Christolea crassifolia</i> Cambess.	0.40	15.00	2.67	0.178	10.84
8	<i>Cousinia thomsonii</i> C. B. Clarke	0.38	10.00	3.75	0.375	21.69
9	<i>Dracocephalum heterophyllum</i> Benth.	0.90	15.00	6.00	0.400	17.44
10	<i>Elymus nutans</i> Griseb.	5.58	20.00	27.88	1.394	45.44
12	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	1.23	17.50	7.00	0.400	19.81
13	<i>Nepeta</i> sp.	0.90	15.00	6.00	0.400	15.25
14	<i>Oxytropis mollis</i> Benth.	0.23	12.50	1.80	0.144	8.22
15	<i>Polygonum cognatum</i> Meisn.	0.18	7.50	2.33	0.311	5.34

16	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	0.20	7.50	2.67	0.356	5.07
17	<i>Potentilla bifurca</i> Linn.	0.10	5.00	2.00	0.400	2.89
18	<i>Rheum spiciforme</i> Royle	0.18	10.00	1.75	0.175	10.41
11	<i>Scrophularia dentata</i> Royle ex Benth.	1.68	15.00	11.17	0.744	19.22
19	<i>Thalictrum cultratum</i> Wall.	0.15	5.00	3.00	0.600	3.23
20	<i>Thermopsis inflata</i> Cambess.	1.45	17.50	8.29	0.473	18.80

**b) Altitude Range: >4800 m**

A perusal of table 37 for shrubs at site Langza showed that total number of herbs species was 4. *Caragana versicolor* (206.97) was dominant species on the basis of IVI followed by *Krascheninnikovia ceratoides* (52.71) and *Lonicera spinosa* (31.93) and least dominant was *Potentilla arbuscula* (8.39). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (3.03) followed by *Krascheninnikovia ceratoides* (0.85) and *Lonicera spinosa* (0.58) and lowest value (0.08) was observed for *Potentilla arbuscula*. Maximum frequency % was observed for *Caragana versicolor* (40.00) followed by *Krascheninnikovia ceratoides* (20.00) and *Lonicera spinosa* (12.50) and minimum value (5.00) was observed for *Potentilla arbuscula*. Maximum abundance was observed for *Caragana versicolor* (7.56) followed by *Lonicera spinosa* (4.60) and *Krascheninnikovia ceratoides* (4.25) and minimum value (1.50) was observed for *Potentilla arbuscula*. Contiguous distribution pattern was observed for all shrubs at Langza table 37. A perusal of (Table-47) showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 0.52, 0.90, 0.58 and 0.65, respectively at Langza.

**Table-37: Phytosociological attributes of shrubs in Langza at an altitudinal range > 4800 m.**

S. No.	Plant species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	3.03	40.00	7.56	0.189	206.97
2	<i>Krascheninnikovia ceratoides</i> (L.) Gueldenst.	0.85	20.00	4.25	0.213	52.71
3	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.58	12.50	4.60	0.368	31.93
4	<i>Potentilla arbuscula</i> D.	0.08	5.00	1.50	0.300	8.39

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A perusal of table 38 for herbs at site-Langza showed that total number of herb species was 9. *Elymus nutans* (81.87) was dominant species on the basis of IVI followed by *Kobresia royleana* (81.62) and *Potentilla sp.* (32.88) and least dominant was *Silene gonosperma* (9.27). *Kobresia royleana* (10.88) showed highest value for density/m<sup>2</sup> followed by *Elymus nutans* (9.20) and *Kobresia schoenoides* (3.38) and lowest value (0.15) was observed for *Saussurea glacialis*. Maximum frequency % was observed for *Elymus nutans* (20.00) followed by *Potentilla sp.* (15.00) and *Kobresia royleana* (10.00) and minimum value (5.00) was observed for *Stipa capillata*. Maximum abundance was observed for *Kobresia royleana* (108.75) followed by *Elymus nutans* (46.00) and *Kobresia schoenoides* (45.00) and minimum value (2.00) was observed for *Saussurea glacialis*. Contiguous distribution pattern was observed for all the herbs species at Langza (Table 38). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.18, 1.91, 1.14 and 0.87, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 13.15, 7.36 and 45.55, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.40, 129.00, 8.00 and 365.00, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table-38: Phytosociological attributes of herbs species in Langza at an altitudinal range > 4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Elymus nutans</i> Griseb.	9.20	20.00	46.00	2.300	81.87
2	<i>Kobresia royleana</i> (Nees) Boeckeler	10.88	10.00	108.75	10.875	81.62
3	<i>Kobresia schoenoides</i> (C.A.Mey.) Steud.	3.38	7.50	45.00	6.000	23.14
4	<i>Potentilla sp.</i>	1.63	15.00	10.83	0.722	32.88
5	<i>Rheum spiciforme</i> Royle	0.25	10.00	2.50	0.250	28.82
6	<i>Saussurea glacialis</i> Herder.	0.15	7.50	2.00	0.267	16.46
7	<i>Saussurea nana</i> (Pamp.) Pamp.	0.25	7.50	3.33	0.444	14.74

8	<i>Silene gonosperma</i> (Rupr.) Bocquet	0.20	7.50	2.67	0.356	9.27
9	<i>Stipa capillata</i> Linn.	1.20	5.00	24.00	4.800	11.19

**11. Name of Site: Komik (Langza beat)**

**a) Altitude Range: 4400 m-4800 m**

A perusal of table 39 for shrubs at site- Komik showed that total number of species of shrubs was 4. *Caragana versicolor* (218.81) was dominant species on the basis of IVI followed by *Ephedra gerardiana* (35.95) and *Krascheninnikovia ceratoides* (30.52) and least dominant was *Lonicera spinosa* (14.72). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (4.33) followed by *Ephedra gerardiana* (1.08) and *Krascheninnikovia ceratoides* and (0.45) lowest value (0.20) was recorded for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (40.00) followed by *Krascheninnikovia ceratoides* (15.00) and *Ephedra gerardiana* (10.00) and lowest value (7.50) was recorded for *Lonicera spinosa*. Maximum abundance was observed for *Caragana versicolor* (10.81) followed by *Ephedra gerardiana* (10.75) and *Krascheninnikovia ceratoides* (3.00) and minimum value (2.67) was observed for *Lonicera spinosa*. The ratio of A/F indicated that the distribution pattern of all the species was contiguous for shrubs at Komik (Table 39). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 1.05, 0.75, 0.55 and 0.54, respectively at Komik.

**Table 39: Phytosociological attributes of shrubs in Komik at an altitudinal range between 4400 m-4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	4.33	40.00	10.81	0.270	218.81
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	1.08	10.00	10.75	1.075	35.95
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst.	0.45	15.00	3.00	0.200	30.52
4	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.20	7.50	2.67	0.356	14.72

A perusal of table-40 for herbs at site-Komik showed that total number of species of herbs was 20. *Kobresia schoenoides* (48.30) was dominant species on the basis



of IVI followed by *Dracocephalum heterophyllum* (47.11) and *Lindelofia stylosa* (36.73) and least dominant was *Polygonum cognatum* (3.44). *Aconogonum tortuosum* showed highest value for density/m<sup>2</sup> (1.95) followed by *Festuca* sp. (1.40) and *Lindelofia stylosa* (1.13) and lowest value (0.10) was observed for *Polygonum cognatum*. Maximum frequency % was observed for *Dracocephalum heterophyllum* (25.00) followed by *Aconogonum tortuosum* and *Lindelofia stylosa* (17.50), *Rhodiola heterodonta* (12.50) and *Allium carolinianum* (12.50) and minimum value (2.50) was observed for *Urtica hyperborea*. Maximum abundance was observed for *Kobresia schoenoides* (37.50) followed by *Festuca* sp. (18.67), and *Urtica hyperborea* (13.00) and minimum were *Geranium lambertii* (1.50). The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table-40). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.09, 2.66, 2.92 and 0.89, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 5.85, 7.24 and 54.32, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.84, 160.33, 7.52 and 337.48, respectively. Organic carbon (%) was medium. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table-40: Phytosociological attributes of herbs species in Komik at an altitudinal range between 4400 m-4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	1.95	17.50	11.14	0.637	26.15
2	<i>Allium carolinianum</i> DC.	0.80	12.50	6.40	0.512	22.71
3	<i>Allium consanguineum</i> Kunth	0.30	5.00	6.00	1.200	8.92
4	<i>Arabidopsis himalaica</i> (Edgew.) O. E. Schulz	0.53	7.50	7.00	0.933	7.54
5	<i>Artemisia santolinifolia</i> Turcz ex Krasch.	0.58	7.50	7.67	1.022	16.04
6	<i>Dracocephalum heterophyllum</i> Benth.	1.05	25.00	4.20	0.168	47.11
7	<i>Elymus nutans</i> Griseb.	0.23	10.00	2.25	0.225	7.10
8	<i>Festuca</i> sp.	1.40	7.50	18.67	2.489	12.77

9	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	0.15	5.00	3.00	0.600	3.65
10	<i>Geranium lambertii</i> Sweet	0.15	10.00	1.50	0.150	6.17
11	<i>Kobresia schoenoides</i> (C.A.Mey.) Steud.	5.63	15.00	37.50	2.500	48.30
12	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	1.13	17.50	6.43	0.367	36.73
13	<i>Myosotis alpestris</i> F. W. Schmidt	0.48	7.50	6.33	0.844	10.66
14	<i>Nepeta</i> sp.	0.33	5.00	6.50	1.300	4.92
15	<i>Polygonum cognatum</i> Meisn.	0.10	5.00	2.00	0.400	3.44
16	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	0.20	10.00	2.00	0.200	8.41
17	<i>Potentilla bifurca</i> Linn.	0.40	7.50	5.33	0.711	6.74
18	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.38	12.50	3.00	0.240	10.43
19	<i>Thalictrum cultratum</i> Wall.	0.58	7.50	7.67	1.022	8.03
20	<i>Urtica hyperborea</i> Jacq. Ex Wedd.	0.33	2.50	13.00	5.200	4.21

**b) Altitude Range: >4800 m**

A perusal of table 41 for shrubs at site -Komik showed that total number of shrubs species was 2. *Caragana versicolor* (276.06) was dominant species on the basis of IVI and least dominant was *Lonicera spinosa* (23.94). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (2.13) and lowest value (0.20) was observed for *Lonicera spinosa*. Maximum frequency % was observed for *Caragana versicolor* (50.00) and minimum value (7.50) was observed for *Lonicera spinosa*. Maximum abundance was observed for *Caragana versicolor* (4.25) and minimum value (2.67) was observed for *Lonicera spinosa*. Contiguous distribution pattern was observed for both the species at Komik (Table 41). A perusal of table- 47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.85, 0.28, 0.22 and 0.40, respectively at Komik.

**Table-41: Phytosociological attributes of shrubs in Komik at an altitudinal range >4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	2.13	50.00	4.25	0.085	276.06
2	<i>Lonicera spinosa</i> (Decne.) Jacq. ex Walp.	0.20	7.50	2.67	0.356	23.94

A perusal of Table 42 for herbs at site - Komik showed that total number of herbs species was 8. *Elymus nutans* (113.60) was dominant species on the basis of IVI followed by *Kobresia schoenoides* (84.75), and *Potentilla argrophylla* (22.32) and least dominant was *Silene gonosperma* (7.41). *Elymus nutans* showed highest value for density/m<sup>2</sup> (9.45) followed by *Kobresia schoenoides* (5.85) and *Stipa capillata* (1.40) and lowest value (0.20) was observed for *Rhodiola heterodonta*. Maximum frequency % was observed for *Elymus nutans* (37.50) followed by *Kobresia schoenoides* and *Potentilla argrophylla* (15.00), *Paraquilegia microphylla* (10.00) and *Rhodiola heterodonta* (10.00) and minimum value (5.00) were observed for *Silene gonosperma*, *Stipa capillata*, *Gentiana tianschanica*. Maximum abundance was observed for *Kobresia schoenoides* (39.00) followed by *Stipa capillata* (28.00) and *Elymus nutans* (25.20) and minimum value (2.00) was observed for *Rhodiola heterodonta*. Contiguous distribution pattern was observed for all the herbs species at Komik (Table 42). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.24, 1.68, 1.05 and 0.81, respectively table-47. A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 10.33, 7.47 and 67.73, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.28, 118.00, 5.13 and 337.06, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was medium in the study site.

**Table-42: Phytosociological attributes of herbs species in Komik at an altitudinal range > 4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Elymus nutans</i> Griseb.	9.45	37.50	25.20	0.672	113.60
2	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	0.15	5.00	3.00	0.600	20.59

3	<i>Kobresia schoenoides</i> (C.A.Mey.) Steud.	5.85	15.00	39.00	2.600	84.75
4	<i>Paraquilegia microphylla</i> (Royle) J.R Drumm. & Hutch.	0.85	10.00	8.50	0.850	16.92
5	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	0.85	15.00	5.67	0.378	22.32
6	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.20	10.00	2.00	0.200	12.15
7	<i>Silene gonosperma</i> (Rupr.) Bocquet	0.30	5.00	6.00	1.200	7.41
8	<i>Stipa capillata</i> Linn.	1.40	5.00	28.00	5.600	22.26

## 12. Name of Site: Demul (Lalung beat)

### a) Altitude Range: 4400 m-4800 m

A perusal of table-43 for shrubs at the site- Demul showed that total number of species of shrubs was 3. *Caragana versicolor* (175.13) was dominant species on the basis of IVI followed by *Krascheninnikovia ceratoides* (56.72) and least dominant was *Potentilla arbuscula* (9.96). *Caragana versicolor* showed highest value for density/m<sup>2</sup> (5.43) followed by *Krascheninnikovia ceratoides* (1.40) and lowest value (0.65) was observed for *Ephedra gerardiana*. Maximum frequency % was observed for *Caragana versicolor* (45.00) followed by *Krascheninnikovia ceratoides* (20.00) and minimum value (5.00) was recorded for *Ephedra gerardiana*. Highest abundance was observed for *Potentilla arbuscula* (14.33) followed by *Ephedra gerardiana* (13.00) and minimum value (7.00) was observed for *Krascheninnikovia ceratoides*. The ratio of A/F indicated that the distribution pattern of all the species was contiguous for shrubs at Demul (Table 43). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs was 1.07, 0.98, 0.70 and 0.61, respectively at Demul.

**Table-43: Phytosociological attributes of shrubs in Demul at an altitudinal range between 4400 m-4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	5.43	45	12.06	0.268	175.13
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.65	5.00	13.00	2.600	21.78
3	<i>Krascheninnikovia</i>	1.40	20.00	7.00	0.350	56.72

	<i>ceratoides</i> (L.) Gueldenst					
4	<i>Lonicera spinosa</i> (Jacq. ex Decne.) Walp.	0.80	10.00	8.00	0.800	36.41
5	<i>Potentilla arbuscula</i> D. Don	1.08	7.50	14.33	1.911	9.96

A perusal of table 44 for herbs at site- Demul showed that total number of species of herbs was 23. *Elymus nutan* (62.36) was dominant species on the basis of IVI followed by *Aconogonum tortuosum* (51.77), *Cousinia thomsonii* (31.52) and least dominant was *Aconitum* sp. (1.22). *Elymus nutans* showed highest value for density/ m<sup>2</sup> (39.60) followed by *Aconogonum tortuosum* (11.70), *Potentilla bifurca* (6.38) and lowest value (0.15) was observed for *Saussurea taraxicifolia*. Maximum frequency % was observed for *Aconogonum tortuosum* (57.50), followed by *Elymus nutans* (55.00), *Astragalus rhizanthus* (22.50), and minimum value (2.50) was observed for *Aconitum* sp.. Maximum abundance was observed for *Elymus nutans* (72.00) followed by *Rhodiola tibetica* (45.00), *Potentilla bifurca* (36.43) and minimum value (2.00) was observed for *Saussurea taraxicifolia*. The distribution pattern of all the species was contiguous on the basis of A/F ratio (Table-44). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.11, 2.60, 2.69 and 0.83, respectively (Table-47). A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.29, 7.56 and 32.81, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.34, 116.5, 8.15 and 347.38, respectively. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table-44: Phytosociological attributes of herbs species in Demul at an altitudinal range between 4400 m-4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconitum</i> sp.	0.40	2.50	16.00	6.40	1.22
2	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	11.70	57.50	20.35	0.35	51.77
3	<i>Astragalus nivalis</i> Kar. & kir.	3.68	20.00	18.38	0.92	13.14
4	<i>Astragalus rhizanthus</i> Benth.	0.58	22.50	2.56	0.11	7.37
5	<i>Corydalis crassifolia</i> Royle	2.70	20.00	13.50	0.68	28.38

6	<i>Cousinia thomsonii</i> C. B. Clarke	2.45	17.50	14.00	0.80	31.52
7	<i>Elsholtzia eriostachya</i> (Benth.) Benth.	1.18	7.50	15.67	2.09	4.72
8	<i>Elymus nutans</i> Griseb.	39.60	55.00	72.00	1.31	62.36
9	<i>Gentiana tianschanica</i> Rupr. ex Kusn.	2.28	10.00	22.75	2.28	8.78
10	<i>Geranium lambertii</i> Sweet	1.08	20.00	5.38	0.27	7.06
11	<i>Lindelofia longiflora</i> (Benth.) Baill.	1.85	10.00	18.50	1.85	9.45
12	<i>Lindelofia stylosa</i> (Kar. & Kir.) Brand	3.53	20.00	17.63	0.88	19.06
13	<i>Nepeta podostachys</i> Benth.	1.23	17.50	7.00	0.40	6.45
14	<i>Plantago depressa</i> Willd.	0.23	5.00	4.50	0.90	1.69
15	<i>Polygonum cognatum</i> Meisn.	0.48	7.50	6.33	0.84	2.62
16	<i>Potentilla</i> sp.	3.63	12.50	29.00	2.32	7.94
17	<i>Potentilla bifurca</i> Linn.	6.38	17.50	36.43	2.08	13.38
18	<i>Potentilla multifida</i> L.	0.73	7.50	9.67	1.29	3.52
19	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	2.25	5.00	45.00	9.00	5.10
20	<i>Saussurea taraxicifolia</i> Wall. ex DC.	0.15	7.50	2.00	0.27	2.27
21	<i>Stipa</i> sp.	1.45	10.00	14.50	1.45	4.46
22	<i>Taraxacum officinale</i> Wigg.	0.30	7.50	4.00	0.53	2.52
23	<i>Thermopsis inflata</i> Cambess.	1.25	10.00	12.50	1.25	5.22

**b) Altitude Range: >4800 m**

A perusal of table 45 for shrubs at site-Demul showed that total number of shrubs species was 3. *Caragana versicolor* (224.34) was dominant species on the basis of IVI followed by *Ephedra gerardiana* (51.35) and least dominant was *Krascheninnikovia ceratoides* (24.31). *Caragana versicolor* showed highest

value for density/m<sup>2</sup> (2.18) followed by *Krascheninnikovia ceratoides* (0.95), and lowest value (0.15) was observed for *Ephedra gerardiana*. Maximum frequency % was observed for *Caragana versicolor* (40.00) followed by *Krascheninnikovia ceratoides* (20.00) and minimum value (5.00) was observed for *Ephedra gerardiana*. Maximum abundance was observed for *Caragana versicolor* (5.44) followed by *Krascheninnikovia ceratoides* (4.75) and minimum value (5.00) was observed for *Ephedra gerardiana*. Contiguous distribution pattern was observed for other shrubs at Demul (Table 45). A perusal of table-47 showed that concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrub was 0.53, 0.80, 0.41 and 0.73, respectively at Demul.

**Table-45: Phytosociological attributes of shrubs in Demul at an altitudinal range > 4800 m.**

S. No.	Plant Species	Density/ 25 m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Caragana versicolor</i> Benth.	2.18	40.00	5.44	0.136	224.34
2	<i>Ephedra gerardiana</i> Wall. ex Stapf	0.15	5.00	3.00	0.600	51.35
3	<i>Krascheninnikovia</i> <i>ceratoides</i> (L.) Gueldenst	0.95	20.00	4.75	0.238	24.31

A perusal of table 46 for herbs at site-Demul showed that total number of herbs species was 16. *Elymus nutans* (85.16) was dominant species on the basis of IVI followed by *Stipa* sp. (43.65), *Rhodiola tibetica* (37.26) and least dominant was *Saussurea glacialis* (2.21). *Elymus nutans* (16.30) showed highest value for density/m<sup>2</sup> followed by *Stipa* sp. (9.63), *Thermopsis inflata* (1.93), and lowest value (0.15) was observed for *Polygonum cognatum*. Maximum frequency % was observed for *Elymus nutans* (62.50) followed by *Stipa* sp. (27.5), *Aconogonum tortuosum* (22.50) and minimum value (2.50) was observed for *Saussurea glacialis* and *Artemisia* sp. Maximum abundance was observed for *Rhodiola tibetica* (116.00) followed by *Stipa* sp. (35.00), *Elymus nutans* (26.08) and minimum value (2.00) were observed for *Geranium wallichianum*. Contiguous distribution pattern was observed for all the herbs species at Demul (Table 46). Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for herbs was 0.14, 2.31, 2.04 and 0.83 respectively table-47. A perusal of table-48 showed that soil moisture (%), pH and electrical conductivity were 7.30, 7.41 and

51.16, respectively. Organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) were 0.79, 159.20, 6.14 and 338.00, respectively. Organic carbon (%) was medium. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study site.

**Table -46: Phytosociological attributes of herbs species in Demul at an altitudinal range > 4800 m.**

S. No.	Plant Species	Density/ m <sup>2</sup>	Frequency (%)	Abundance	A/F	IVI
1	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	0.95	22.50	4.22	0.188	27.11
2	<i>Arabidopsis himalaica</i> (Edgew.) O. E. Schulz	0.28	7.50	3.67	0.489	5.77
3	<i>Artemisia</i> sp.	<b>0.23</b>	<b>2.50</b>	<b>9.00</b>	3.600	5.07
4	<i>Astragalus rhizanthus</i> Benth.	0.68	12.50	5.40	0.432	14.38
5	<i>Corydalis crassifolia</i> Royle	0.40	7.50	5.33	0.711	12.51
6	<i>Elymus nutans</i> Griseb.	16.30	62.50	26.08	0.417	85.16
7	<i>Geranium wallichianum</i> D. Don ex Sweet	0.20	10.00	2.00	0.200	5.70
8	<i>Nepeta podostachys</i> Benth.	0.58	7.50	7.67	1.022	8.55
9	<i>Oxytropis mollis</i> Benth.	0.23	7.50	3.00	0.400	7.22
10	<i>Polygonum cognatum</i> Meisn.	0.15	5.00	3.00	0.600	3.08
11	<i>Potentilla argrophylla</i> Wall. ex Lehm.	0.35	12.50	2.80	0.224	9.89
12	<i>Rhodiola heterodonta</i> (Hook. f. & Th.) Boriss	0.35	7.50	4.67	0.622	16.57
13	<i>Rhodiola tibetica</i> (Hook.f. & Thompson) S. H. Fu	5.80	5.00	116.00	23.200	37.26
14	<i>Saussurea glacialis</i> Herder.	0.30	2.50	12.00	4.800	2.21
15	<i>Stipa</i> sp.	9.63	27.50	35.00	1.273	43.65



16	<i>Thermopsis inflata</i> Cambess.	1.93	10.00	19.25	1.925	15.86
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**Table-47: Concentration of dominance (C), diversity index (H), richness index (R) and evenness index (E) for shrubs and herbs at different altitudes in Kibber Wildlife Sanctuary.**

Altitude (m)	Name of Site	Habit	Concentration of Dominance (C)	Diversity Index (H)	Richness Index (R)	Evenness Index (E)
<4400	Chhichham-1	Shrub	1.11	1.13	0.69	0.70
		Herb	0.09	2.52	2.19	0.95
4400-4800	Badang	Shrub	1.06	0.83	0.52	0.60
	Dhinam		1.05	0.93	0.69	0.58
	Chhichham-1		0.46	1.17	1.02	0.24
	Chhichham-2		1.05	0.70	0.57	0.43
	Gete		1.07	1.05	0.69	0.65
	Ladarcha		1.06	0.82	0.56	0.51
	Racholakmo		0.61	0.83	0.69	0.52
	Gipsian Lumpa		0.68	0.61	0.48	0.44
	Chumik Shaltay		0.55	0.79	0.34	0.72
	Langza		1.13	1.16	0.69	0.72
	Komik		1.05	0.75	0.55	0.54
	Demul		1.07	0.98	0.70	0.61
	Badang	Herb	0.11	2.47	2.64	0.89
	Dhinam		0.12	2.76	3.73	0.83
	Chhichham-1		0.09	2.71	3.24	0.90
	Chhichham-2		0.14	2.33	2.45	0.81
	Gete		0.10	2.64	3.14	0.85
	Ladarcha		0.14	2.28	2.06	0.82
	Racholakmo		0.19	1.81	0.97	0.93
	Gipsian Lumpa		0.16	2.10	1.49	0.88
	Chumik Shaltay		0.23	1.74	2.62	0.61
	Langza		0.08	2.74	2.76	0.91

	Komik		0.09	2.66	2.92	0.89
	Demul		0.11	2.60	2.69	0.83
>4800	Badang	Shrub	0.78	0.38	0.18	0.55
	Dhinam		0.58	0.84	0.55	0.61
	Chhichham-2		0.85	0.33	0.33	0.30
	Gete		0.59	0.89	0.76	0.55
	Ladarcha		0.90	0.20	0.16	0.29
	Chumik Shaltay		0.50	0.87	0.38	0.79
	Langza		0.52	0.90	0.58	0.65
	Komik		0.85	0.28	0.22	0.40
	Demul		0.53	0.80	0.41	0.73
	Badang	Herb	0.21	1.89	1.44	0.79
	Dhinam		0.12	2.37	2.04	0.90
	Chhichham-2		0.22	1.86	1.53	0.78
	Gete		0.14	2.28	2.23	0.82
	Ladarcha		0.25	1.74	1.06	0.79
	Chumik Shaltay		0.27	1.52	0.93	0.78
	Langza		0.18	1.91	1.14	0.87
	Komik		0.24	1.68	1.05	0.81
	Demul		0.14	2.31	2.04	0.83

**Table 48: Analysis of physico-chemical properties of soil in Kibber Wildlife Sanctuary.**

Sl. No.	Altitudinal Range (m)	Name of Site	Moisture (%)	pH	EC ( $\mu$ s)	Organic Carbon (%)	Available Nitrogen (Kg/ha)	Available Phosphorus (Kg/ha)	Available Potassium (Kg/ha)
<b>1</b>	<b>&lt;4400</b>	Chhichham-1	7.52	7.80	43.25	0.46	121	8.23	349.56
<b>2</b>	<b>4400-4800</b>	Badang	7.87	7.77	78.14	0.85	160.00	7.14	338.72
		Dhinam	6.21	7.32	42.25	0.44	117.60	6.52	337.38
		Chhichham-1	7.32	7.77	39.28	0.47	120.20	7.12	354.00
		Chichham-2	7.44	7.67	44.21	0.48	120.00	9.21	355.26
		Gete	6.50	7.78	43.20	0.45	118.20	4.21	344.70
		Ladarcha	7.98	7.81	69.32	0.78	140.21	9.15	362.16
		Racholakmo	6.82	7.20	65.14	0.41	105.16	10.80	367.90
		Gipsian Lumpa	4.91	7.10	62.31	0.21	107.23	8.95	390.00
		Chumik Shaltay	9.10	6.90	61.21	0.45	108.54	7.36	348.00
		Langza	11.32	6.95	45.44	0.58	139.00	6.18	261.00
		Komik	5.85	7.24	54.32	0.84	160.33	7.52	337.48
		Demul	7.29	7.56	32.81	0.34	116.5	8.15	347.38
<b>3</b>	<b>&gt;4800</b>	Badang	7.20	7.72	33.31	0.35	112.00	6.29	343.38
		Dhinam	6.18	7.32	41.25	0.36	112.26	8.25	371.68
		Chichham-2	7.48	7.69	45.31	0.43	121.25	5.25	350.50
		Gete	6.20	7.65	38.26	0.44	115.23	6.55	341.56
		Ladarcha	8.01	7.83	69.56	0.61	141.00	6.18	366.00
		Chumik Shaltay	8.90	7.01	59.23	0.37	107.10	5.40	340.90
		Langza	13.15	7.36	45.55	0.40	129.00	8.00	365.00
		Komik	10.33	7.47	67.73	0.28	118.00	5.13	337.06
		Demul	7.30	7.41	51.16	0.79	159.20	6.14	338.00

## 18. Threatened Plants:

Total 5 numbers of species was found threatened out of 116 species recorded in Kibber Wild Life Sanctuary. The name of threatened species are *Arnebia euchroma*, *Berginia stracheyi*, *Ephedra gerardiana*, *Physochlaena praealta* and *Rhodiola heterodonta* (Goraya *et al.*, 2013). The status of *Rheum spiciforme* is near threatened (Goraya *et al.*, 2013). The habitat alteration, narrow range of distribution and over grazing, over harvesting are the main reason for less population of these threatened plants. Another reason is the uprooting of these economically important plants for using the underground parts of the plants for medicine and other uses.

The standardized cultivation technology and practices are required so that people residing around the boundary of the sanctuary can cultivate these plants in their agricultural lands to fulfill their demands because people prefer to use wild plants from their natural distribution zone.

## 19. Summary:

The present investigations entitled “Assessment of vegetation in Kibber Wildlife Sanctuary, Distt. Lahaul-Spiti, Himachal Pradesh.” was carried out in Forest Ecology and Climate Change Division, Himalayan Forest Research Institute, Panthaghati, Shimla during 2016-2019.

Studies were conducted in twelve sites in Kibber Wild Life Sanctuary. The name of study sites were Badang, Komik, Langza, Demul, Chhicham-1, Chicham-2, Dhinam, Gete, Ladarcha, Rachmolaka Nalla, Gypsyan lumpa and Chumik shalthey.

Vegetation data was collected using 20 quadrats of 5m x 5m for shrubs, 40 quadrats of 1m x 1m for herbs. Analysis of phyto-sociological data and physico-chemical properties of soil were done as per standard methodology. A summary of results pertaining to assessment of vegetation and physico-chemical properties of soil is presented as follows:

Total 116 number of plant species were recorded which belong to 71 genus and 33 families during floristic survey in Kibber WLS. Total 9 species of shrubs and 107 species herbs were recorded. Asteraceae was dominant family followed by Fabaceae and Rosaceae. The 101 species were observed in the selected 12 sampling sites.

### **Altitude Range < 4400:**

At an elevation < 4400 m, only one study site was found i.e. Chhichham-1. 17 families, 18 genus and 20 species were recorded at this site in Kibber Wildlife

Sanctuary. Out of these 13 families, 15 genus and 15 species belongs to herbs and 5 families, 5 genus and 5 species belongs to shrubs respectively. The maximum species were recorded from Boraginaceae, Lamiaceae, Polygonaceae and Rosaceae.

Phytosociological analysis of shrubs at Chichham-1 (< 4400 m) site revealed that *Caragana versicolor* (58.14) was dominant species followed by *Ephedra gerardiana* (26.54) on the basis of IVI and least dominant was *Potentilla arbuscula* (15.74). The distribution pattern was contiguous for shrubs. The value of concentration of dominance (C) for shrubs was 1.11 (Chhichham-1). Diversity index (H) value was 1.13 (Chhichham-1). The value of richness index (R) was 0.69 (Chhichham-1). The value of evenness index (E) was 0.70 (Chhichham-1).

13 families, 15 genus and 15 species belongs to herbs in Chhichham-1 site (<4400m). Maximum number of genus of herbs were recorded from the family Boraginaceae and Polygonaceae. At site Chichham-1 (<4400m), *Elymus nutans* (38.10) was dominant species on the basis of IVI followed by *Bistorta affinis* (20.60) and least dominant was *Aconitum* sp. (8.00) and *Geranium himalayense* (8.00). The value of concentration of dominance (C) for herbs was 0.09 (Chhichham-1 <4400m). Diversity index (H) value is 2.52 (Chhichham-1 <4400m). The value of richness index (R) was 2.19 (Chhichham-1 <4400m). The value of evenness index (E) was 0.95 (Chhichham-1 <4400m). A perusal of (Table-48) showed that soil moisture (%), pH range, electrical conductivity, organic carbon (%), available nitrogen (Kg/ha), available phosphorus (Kg/ha) and available potassium (Kg/ha) is 7.52, 7.80, 43.25, 0.46, 121, 8.23 and 349.56, respectively at Chichham-1. Organic carbon (%), available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was high in the study sites.

#### **Altitude Range: 4400-4800 m:**

Studies at an elevation 4400m- 4800m revealed that 29 families, 60 genus and 88 species were recorded in all selected sites in Kibber Wildlife Sanctuary. Out of these, 24 families, 56 genus and 78 species belongs to herbs and 8 families, 8 genus and 9 species belongs to shrubs respectively. The maximum species were recorded from Astraceae followed by Fabaceae and Rosaceae.

Phytosociological analysis of shrubs indicated that *Caragana versicolor* was dominant species in all the studied sites. The distribution pattern was contiguous for shrubs. Highest value of concentration of dominance (C) for shrubs was 1.13 (Langza) and lowest value was 0.46 (Chhichham-1). Diversity index (H) ranged

from 0.61 (Gipsian Lumpa) to 1.17 (Chhichham-1). Highest value of richness index (R) was 1.02 at Chhichham-1 and lowest value 0.34 at Chumik Shaltay respectively. Highest value of evenness index (E) was 0.72 at Chumik Shaltay and Langza and lowest was 0.24 at Chhichham-1.

Maximum number of herbs genus were recorded from the family Astraceae and followed by Fabaceae, Lamiaceae and Rosaceae. Analysis of data for herbs revealed that *Elymus nutans* (61.64) was dominant species on the basis of IVI followed by *Allium carolinianum* (49.73) and least dominant was *Arabidopsis himalaica* (6.14) at Badang. At Dhinam, *Elymus nutans* (84.00) was dominant species on the basis of IVI followed by *Stipa* sp. (44.84) and least dominant *Aconogonum tortuosum* (2.72).

At Chichham-1, *Elymus nutans* (36.41) was dominant species on the basis of IVI followed by *Allium carolinianum* (22.23) and least dominant was *Thymus linearis* (7.40). At Chichham-2, *Allium carolinianum* (69.44) was dominant species on the basis of IVI followed by *Elymus nutans* (65.47) and least dominant was *Thalictrum cultratum* (3.95).

At Gete, *Elymus nutans* (87.02) was dominant species on the basis of IVI followed by *Carex* sp. (37.99) and least dominant was *Aconitum* sp. (6.70). At Ladarcha, *Bergenia stracheyii* (81.88) was dominant species on the basis of IVI followed by *Allium carolinianum* (37.48) and least dominant was *Potentilla desertorum* (2.31).

At Racholakmo, *Elymus nutans* (87.19) was dominant species on the basis of IVI followed by *Tanacetum nubigenum* (65.79) and least dominant was *Physochlaena praealta* (15.24). At site Gipsian Lumpa, *Artemisia salsoloides* (87.70) was dominant species on the basis of IVI followed by *Elymus nutans* (59.81) and least dominant was *Rheum speciforme* (9.05). At Chumik Shaltay, *Elymus nutans* (109.75) was dominant species on the basis of IVI followed by *Artemisia santolinifolia* (76.83) and least dominant was *Nepeta eriostachya* (5.16).

At Langza, *Elymus nutans* (45.44) was dominant species on the basis of IVI followed by *Allium carolinianum* (38.79) and least dominant was *Potentilla bifurca* (2.89). At Komik, *Kobresia schoenoides* (48.30) was dominant species on the basis of IVI followed by *Dracocephalum heterophyllum* (47.11) and least dominant was *Polygonum cognatum* (3.44). At Demul, *Elymus nutan* (62.36) was dominant species on the basis of IVI followed by *Aconogonum tortuosum* (51.77), *Cousinia thomsonii* (31.52) and least dominant was *Aconitum* sp. (1.22).

The common pattern of distribution was contiguous for herbs. Highest value of concentration of dominance (C) for herbs was 0.23 (Chumik Shaltay) and lowest was 0.08 (Langza). Diversity index (H) ranged from 1.74 (Chumik Shaltay) to 2.76 (Dhinam). Highest and lowest value of richness index (R) was 3.73 and 0.97 at Dhinam and Racholakmo, respectively. Highest value of evenness index (E) was 0.93 at Racholakmo and lowest was 0.61 at Chumik Shaltay.

A perusal table-48 showed that soil moisture % varies from 4.91 (Gipsian Lumpa) to 11.32 (Langza). pH ranges from 6.90 (Chumik Shaltay) to 7.81 (Ladarcha) and electrical conductivity ( $\mu$ s) varies from 32.81 (Demul) to 78.14 (Badang). The lowest value of organic carbon (%) was 0.21 (Gipsian Lumpa) and highest value was 0.84 (Komik). Available nitrogen (Kg/Ha) varies from 105.16 (Racholakmo) to 160.33 (Komik). Available phosphorus (Kg/Ha) ranges from 4.21 (Gete) to 10.80 (Racholakmo) and available potassium (Kg/Ha) varies from 261.00 (Langza) to 390.00 (Gipsian Lumpa) (Table-48). Organic carbon (%) ranges from very low to medium. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) was ranged between medium to high in the study sites.

#### **Altitude Range >4800 m:**

At an elevation > 4800m, 25 families, 41 genus and 60 species were recorded in all selected sites in Kibber Wildlife Sanctuary. Out of these, 22 families, 37 genus and 54 species belongs to herbs and 5 families, 5 genus and 6 species belongs to shrubs respectively. The maximum species were recorded from Fabaceae followed by Asteraceae, Lamiaceae and Rosaceae.

Phytosociological analysis of shrubs indicated that *Caragana versicolor* was dominant species in all the studied sites. The distribution pattern was contiguous for shrubs. Highest value of concentration of dominance (C) for shrubs was 0.90 (Ladarcha) and lowest value was 0.50 (Chumik Shaltay). Diversity index (H) ranged from 0.20 (Ladarcha) to 0.90 (Langza). Highest and lowest value of richness index (R) was 0.76 and 0.16 at Gete and Ladarcha, respectively. Highest value of evenness index (E) was 0.79 at Chumik Shaltay and lowest was 0.29 at Ladarcha.

22 families, 37 genus and 54 species belongs to herbs in all site at an elevation >4800m. Maximum number of genus were recorded from the family Fabaceae followed by Astraceae, Polygonaceae, Poaceae and Rosaceae. The common pattern of distribution was contiguous for herbs. Highest value of concentration of dominance (C) for herbs was 0.27 (Chumik Shaltay) and lowest was 0.12

(Dhinam). Diversity index (H) ranged from 1.52 (Chumik Shaltay) to 2.37 (Dhinam). Highest and lowest value of richness index (R) was 2.23 and 0.93 at Gete and Chumik Shaltay, respectively. Highest value of evenness index (E) was 0.90 at Dhinam and lowest was 0.78 at Chumik Shaltay and Chhichham-2.

At Badang site (>4800m), *Elymus nutans* (102.33) was dominant species on the basis of IVI followed by *Stipa capillata* (72.91) and least dominant was *Aconitum* sp. (5.29). *Elymus nutans* (69.66) was dominant species on the basis of IVI followed by *Stipa* sp. (45.44) and least dominant was *Aconitum* sp. (5.45) at Dhinam.

*Elymus nutans* (115.66) was dominant species on the basis of IVI followed by *Rhodiola tibetica* (59.72) and least dominant was *Geranium himalayense* (2.44) at Chichham-2. At Gete site (>4800m), *Lindelofia stylosa* (70.22) was dominant species on the basis of IVI followed by *Carex* sp. (64.96) and least dominant was *Aconitum* sp. (1.71).

*Calamagrostis* sp. (115.74) was dominant species on the basis of IVI at Ladarcha followed by *Berginia stracheyi* (48.34) and least dominant was *Christolea himalayensis* (1.97). At Chumik Shaltay (>4800), *Rhodiola tibetica* (111.78) was dominant species on the basis of IVI followed by *Elymus nutans* (99.23) and *Elsholtzia eriostachya* (38.04) and least dominant was *Paraquilegia microphylla* (9.22).

*Elymus nutans* (81.87) was dominant species at Langza followed by *Kobresia royleana* (81.62) and least dominant was *Silene gonosperma* (9.27). *Elymus nutans* (113.60) was dominant species on the basis of IVI followed by *Kobresia schoenoides* (84.75) and least dominant was *Silene gonosperma* (7.41) at Komik. At Demul (>4800), *Elymus nutans* (85.16) was dominant species on the basis of IVI followed by *Stipa* sp. (43.65) and least dominant was *Saussurea glacialis* (2.21).

Soil moisture % varies from 6.18 (Dhinam) to 13.15 (Langza). pH ranges from 7.01 (Chumik Shaltay) to 7.83 (Ladarcha) and EC varies from 33.31 (Badang) to 69.56 (Ladarcha). The lowest value of organic carbon (%) was 0.28 (Komik) and highest value was 0.79 (Demul). Available nitrogen (Kg/Ha) varies from 107.10 (Chumik Shaltay) to 159.20 (Demul). Available phosphorus (Kg/Ha) ranges from 5.13 (Komik) to 8.25 (Dhinam) and available potassium (Kg/Ha) varies from 337.06 (Komik) to 366.00 (Ladarcha) (Table-48). Organic carbon (%) ranges from low to medium. Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were



recorded low. Available potassium (Kg/ha) was ranged between medium to high in the study sites.

Total five threatened plants i.e. *Arnebia euchroma*, *Berginia stracheyi*, *Ephedra gerardiana*, *Physochlaena praealta* and *Rhodiola heterodonta* were recorded in the Kibber Wildlife Sanctuary.. The status of *Rheum spiciforme* is near threatened (Goraya *et al.*, 2013).

## 19. Conservation Strategies

- Permanent plots may be laid out for the long term monitoring of floristic diversity for understanding the dynamics of vegetation and impact of climate change.
- Monitoring of threatened, endemic and economically important species should be done at regular interval.
- Rotational grazing should be done in the wildlife sanctuary.
- Promotion of ex-situ conservation of threatened, endemic and economically important species may be encouraged.
- Education and awareness programmes on the status and conservation of floristic diversity should be organised.
- Pastures should be managed by introduction of native grasses.
- There is a need of developing propagation techniques for plants used by local people for various purposes.

## 20. Conclusions

Total 116 species was recorded during floristic survey. Total number of 9 shrubs and 92 herbs species were observed in 12 selected study sites. The maximum species were recorded from Asteraceae followed by Fabaceae and Rosaceae.

Phytosociological analysis of shrubs indicated that *Caragana versicolor* was dominant species in all the studied sites. The distribution pattern was contiguous for shrubs. Highest value of concentration of dominance (C) for shrubs was 1.13 at Langza (4400m- 4800m) and lowest value was 0.46 at Chhichham-1 (4400 m-4800m). Diversity index (H) ranged from 0.20 (Ladarcha >4800m) to 1.17 at Chhichham-1 ( 4400 m-4800m). Highest and lowest value of richness index (R) was 1.02 and 0.16 at Chhichham-1 (4400 m-4800m) and Ladarcha (>4800m), respectively. Highest value of evenness index (E) for shrubs was 0.79 at Chumik

Shaltay (>4800m) and lowest was 0.24 at Chichham-1 (4400m- 4800m). One species of shrub (*Ephedera gerardiana*) was found threatened in Kibber Wildlife Sanctuary.

26 families, 59 genus and 92 species of herbs were recorded from the 12 sampling sites in Kibber Wildlife Sanctuary. Maximum number of genus were recorded from the family Astraceae followed by Fabaceae.

On the basis of IVI, at Badang site (4400-4800m), *Elymus nutans* was dominant species on the basis of IVI and least dominant was *Arabidopsis himalaica* and at Badang site (>4800m). At Badang site (>4800m), *Elymus nutans* was dominant species and least dominant was *Aconitum* sp.

At site Dhinam (4400-4800m), *Elymus nutans* was dominant species on the basis of IVI and least dominant was *Aconogonum tortuosum* and at Dhinam site (>4800m), *Elymus nutans* was dominant species and least dominant was *Aconitum* sp. at Dhinam. At Chichham-1 (<4400m), *Elymus nutans* was dominant species and least dominant was *Aconitum* sp. and *Geranium himalayense* and at Chichham-1 (4400-4800m), *Elymus nutans* was dominant species on the basis of IVI and least dominant was *Thymus linearis*.

At site Chichham-2 (4400-4800m), *Allium carolinianum* was dominant species on the basis of IVI and least dominant was *Thalictrum cultratum* and at Chichham-2 (>4800m), *Elymus nutans* was dominant species and least dominant was *Geranium himalayense*.

At Gete site (4400-4800m), *Elymus nutans* was dominant species on the basis of IVI and least dominant was *Aconitum* sp. and at Gete site (>4800m), *Lindelofia stylosa* was dominant species and least dominant was *Aconitum* sp.

At site Ladarcha (4400-4800m), *Bergenia stracheyii* was dominant species on the basis of IVI and least dominant was *Potentilla desertorum* and at site Ladarcha (>4800m), *Calamogrostis* sp. was dominant species and least dominant was *Christolea himalayensis*. At site Racholakmo (4400-4800m), *Elymus nutans* was dominant species and least dominant was *Physochlaena praealta*.

At site Gipsian Lumpa (4400-4800m), *Artemisia salsoloides* was dominant species on the basis of IVI and least dominant was *Rheum speciforme*.

At site Chumik Shaltea (4400-4800m), *Elymus nutans* was dominant species on the basis of IVI and least dominant was *Nepeta eriostachya* and at Chumik Shaltea

(>4800), *Rhodiola tibetica* was dominant species and least dominant was *Paraquilegia microphylla*.





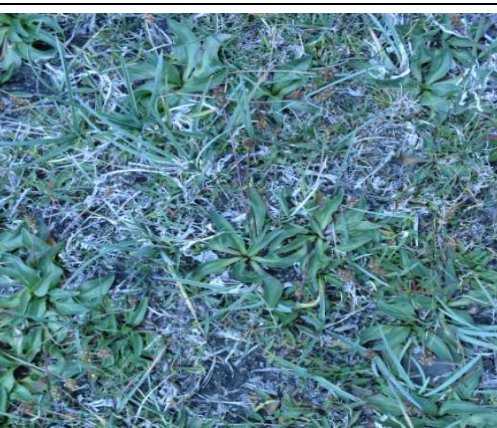

A site Langza (4400-4800m), *Elymus nutans* was dominant species on the basis of IVI and least dominant was *Potentilla bifurca* and at Langza site (>4800), *Elymus nutans* was dominant species and least dominant was *Silene gonosperma*. At Komik site (4400-4800), *Kobresia schoenoides* was dominant species and least dominant was *Polygonum cognatum* and at Komik site (>4800), *Elymus nutans* was dominant species and least dominant was *Silene gonosperma*.

At Demul site (4400-4800m), *Elymus nutan* was dominant species on the basis of IVI and least dominant was *Aconitum* sp. and at Demul (>4800), *Elymus nutans* was dominant species and least dominant was *Saussurea glacialis*.

The common pattern of distribution was contiguous for herbs. Highest value of concentration of dominance (C) for herbs was 0.27 (Chumik Shaltay >4800m) and lowest was 0.08 (Langza 4400-4800m). Diversity index (H) of herbs ranged from 1.52 (Chumik Shaltay >4800m) to 2.74 (Langza 4400-4800m). Highest and lowest value of richness index (R) was 3.24 and 0.93 at Chhichham-1 at altitude range 4400m- 4800m and Chumik Shaltay >4800m respectively. Highest value of evenness index (E) was 0.95 (Chhichham-1 <4400) and lowest was 0.61 (Chumik Shaltay 4400-4800m) for herbs.

Out of 107 herb species, four species i.e. *Arnebia euchroma*, *Berginia stracheyi*, *Physochlaena praealta* and *Rhodiola heterodonta* were found threatened in Kibber Wildlife Sanctuary. The status of *Rheum spiciforme* Royle is near threatened (CAMP, 2010).

Soil moisture % varies from 4.91 to 13.15, EC ( $\mu$ s) varies from 32.18 to 78.14 and pH range varies from acidic to basic. Organic carbon (%) was observed in the range between very low to medium, Available nitrogen (Kg/ha) and available phosphorus (Kg/ha) were recorded low. Available potassium (Kg/ha) ranged from medium to high in study sites.

	
<i>Thalictrum foetidum</i> Linn.	<i>Taraxacum officinale</i> Wigg.
	
<i>Astragalus candolleanus</i> Royle ex Benth.	<i>Ephedra gerardiana</i> Wall. ex Stapf
	
<i>Plantago depressa</i> Willd.	<i>Urtica hyperborea</i> Jacq. Ex Wedd.

**Plate -7: Some plants of Kibber Wildlife Sanctuary**



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## **21. Acknowledgment:**

I am thankful to the Director, Himalyan Forest Research Institute, Panthaghati, Shimla for providing infrastructural facilities, encouragement and guidance. I am also thankful Principal Chief Conservator of Forests (Wildlife) for providing financial grant to execute the study and also thankful to Chief conservator of Forests, Wildlife (South) for encouragement to complete this research project.

I would like to thank Divisional Forest Officer, Spiti Wildlife Division, Sh. Devender Chauhan, FRO (Wildlife) and staff of the Kibber Wildlife Sanctuary, Lahual-Spiti for providing assistance during the field work. I am thankful to Dr. K. S. Kapoor, Former Head of Division, Forest Ecology and Climate Change Division, HFRI for his kind help and support. I am pleased to express my gratitude to the staff involved in various capacities in the present work. I would like to thank Dr. R. K. Verma, Scientist-G and Head of Division, Dr. Vaneet Jishtu, Scientist-D, Miss Shilpa, ACTO, Sh. Dushyant Kumar, T.O, Sh. Kulwant Rai Gulshan, Senior Technician, Sh. Purshottam Thakur, Deputy Ranger, Sh. Manoj Thakur, Forest Guard, Sh. Chaman Thakur, JRF, Sh. Suraj Kumar, JRF, Sh. Baldev, FA and Sh. Pankaj Sharma, FA, Sh. Zuber and Sh. Ajay Thakur, Forester for their assistance in this project. I express my heartfelt thanks to former Director, Dr. G. S. Rawat, WII, Dehradun and Dr. M. K Seth, Professor (Retd.) of H.P.U., Shimla for their help in the identification of plants.

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<p><i>Oxytropis mollis</i> Benth.</p>	<p><i>Rhodiola tibetica</i> (Hook.f. &amp; Thomson)</p>
	
<p><i>Askellia flexuosa</i> (Ledeb.) W. A. Weber</p>	<p><i>Silene rechingeri</i> Bocquet</p>
	
<p><i>Rhodiola heterodonta</i> (Hook. f. &amp; Thomson) Boriss</p>	<p><i>Christolea crassifolia</i> Cambess.</p>

**Plate -8: Some plants of Kibber Wildlife Sanctuary**