Threat Categorization and Conservation Prioritization of Floristic Diversity in Pangi Valley of Himachal Pradesh, North Western Himalaya

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Abstract

Extinction is the most irreversible phenomenon of all the major environmental calamities happened on earth crust. Biodiversity extinction rate is faster than the natural extinction with the results of changes land use pattern, unsustainable use of natural resources, pollution, habitat degradation, climate change, invasion of alien species, conversion of forest land for cultivation and residential as well as commercial purposes resulting in natural habitat degradation and is a direct cause of extinction and loss of biodiversity. In the present investigation, an approach has been developed to prioritize species at local level in Pangi valley, District Chamba by using six conservation attributes i.e., population size, habitat preference, distribution range, anthropogenic pressures, extraction trend, use pattern, endemism and nativity. Threat categories of floristic diversity were identified on the basis of Conservation Priority Index. Of the total 780 species of vascular plants recorded, 95 species were fallen under different threat categoriesi.e.,14 species Critically Endangered,18 Endangered,25 Vulnerable,38 Near Threatened and other species were under Least Concern category. As per IUCN threatened list, out of total, 02 species were reported under Critically Endangered, 07 Endangered, 05 Vulnerable, 02 Near Threatened and remaining species under Least Concern categories. Out of total, 08 species were reported under Critically Endangered,09 Endangered 08 Vulnerable by many researchers in Himachal Pradesh. Maximum 75 threatened species were identified between 2801-3800m; 31 were recorded in *Cedrus deodara* community, followed by 24 in *Betula utilis* community. The overexploitations and unsustainable use of natural resources and destruction of habitats contribute to the major loss of biodiversity. Therefore, regular monitoring of populations and habitats, development of conventional protocols, establishment of species in-situ conditions and habitats and replication of this approach in other parts of Indian Himalayan Region have been suggested.

1. Introduction

The Earth planet comprising of rich biodiversity elements, is a major option for livelihood and sustenance, which provides about thirteen different ecosystem services to mankind (Costanza et al., 1997: Tali et al., 2015).Biodiversity ensures natural sustainability for all living beings on the planet connected with food chain. This earth planet contains a layer of living beings called biosphere interconnected through the cumulative metabolic activities of biotic and abiotic components physically as well chemically connected with geosphere, atmosphere and hydrosphere in a single system of environment, supports millions of species, including human beings. But, this crucially important reservoir of biodiversity is under tremendous pressure due to habitat loss. The International Union for Conservation of Nature (IUCN) estimated that, 20,000–25,000 species of the total, about 10% of vascular plants are facing degree of threats and about 25% of the floristic diversity on the earth crust may be extinct in the next 50 years period (Samant et al., 1996b)and probability of this loss is about 1,000 to 10,000 times more than natural expected extinction rate (Hilton &Taylor, 2000).Local inhabitants of the IHR mostly depend upon the biodiversity available for their sustenance. Tremendous increase in human population results of decline in bioresources, which worked as eye opener to the planners and experts for the conservation of natural resources (Samant & Dhar, 1997).In worldwide, the biodiversity extinction rate is faster than the natural extinction with the results of changes land use pattern, unsustainable use of natural resources, pollution, habitat degradation, climate change, invasion of alien species, conversion of forest land for cultivation and residential as well as commercial purposes resulting in natural habitat degradation and is a direct cause of extinction and loss of biodiversity. Fragmentation and degradation of > 70% of the natural habitats has given a place to Himalaya as a Biodiversity Hotspot and original25% natural habitats have been unaffected by human interface (Mittermeier et al., 2004).The overexploitations and unsustainable use of natural resources and destruction of habitats contribute to the major loss of biodiversity in the region of Indian Himalaya. Expansion of invasive or alien and non-native species into an ecosystem with narrow range of geographical distribution of endemic and native species has a major impact on biodiversity. The disturbance in community structure is a major threat to biodiversity the (Novasek & Cleland, 2001).In worldwide, lots of works have been done by some workers. Ayensu (1981) worked on threatened plant assessment for their conservation aspects in USA: Beloussov & Demissiva (1981) published Red Data Book and its compilation for threatened plant species for conservation; Sakai et al.(2002) worked on patterns of endangerment in Hawaiian flora; Heywood & Iriondo (2003) worked on Global Biodiversity Assessment for threatened plant species; Liu et al.(2007) worked on assessment of ecological risk by applying RAPD and pattern of distribution among rare and endangered species, IUCN (2003) has published a Red Data Book for updating the information on the threat category species; Mace & Lande (1991) worked on identification of threatened plants species; Mace & Stuart (1994) used a new basis for threat categories to update the IUCN, 1996 threatened trees Red list; Oldfield et al.(1998) updated the world list of threatened trees. In India, Botanical Survey of India (BSI) published the Red Data Book for Indian plant species on the basis of information available at regional, state and national level (Nayar & Sastry, 1987, 1988, 1990; Jain & Sastry, 1980, 1984). They made efforts to document the information on threatened plants through Red Data Book). By using the parameters named as population size, habitat preference, distribution range, anthropogenic pressures, extraction trend, use pattern, endemism and nativity of species, attempts for the identification of threatened species in the IHR have been done by various workers and coworkers (Samant et al., 1996b; Rawal & Dhar, 1997; Joshi et al., 1999; Samant, 1999; Samant et al., 2001ab&c; Dhar, 2002; Ved et al., 2003; Arya, 2002; Joshi, 2002; Kala, 2005b; Pant, 2005; Bari, 2006; Semwal et al., 2007; Sajem et al., 2008; Pant & Pant, 2011; Baig et al., 2013; Tali et al., 2015; Barik et al., 2018; Pandey et al., 2019; Mehta et al., 2020a&b; Sofi et al., 2022; Wani et al., 2023; etc.). However, in Himachal Pradesh, a very few investigations have been carried out on the threatened plants (Samant et al., 2006a, 2007a,b; Kala, 2000; Ved et al., 2003; Samant & Pant, 2006; Singh, 2007; Lal, 2007; Rana & Samant, 2010; Sakshi, 2009; Samant et al., 2010, 2012; Sharma et al., 2017; Sharma & Samant, 2015; Samant, 2015; Rana & Haseeb, 2016; Lal et al., 2020; Sharma et al., 2020; Jishtu et al., 2021;Sofi et al., 2022; etc.). Since then, various investigations have been done in the unprotected and protected regions of Himachal Pradesh (Rana, 2007; Lal, 2007; Singh, 2007; Sharma, 2008; Sakshi, 2009; Singh et al., 2009; Samant et al., 2010; Rana & Samant, 2010; Marpa, 2013; Sharma et al., 2017: Sharma, 2017; Samant, 2015; Devi, 2018; Kumar, 2018; Bodh, 2018; Paul et al., 2019; Sharma et al., 2019; Jishtu et al., 2021; Singh et al., 2022; etc.). The same approach is being replicated in different areas, so the actual IUCN threat status of the plant species could be identified. Specific study about threat categorization is crucial to investigate the present biodiversity threat status in investigating area/site. This study would be useful for knowing the present status and establishing conservation priorities and management policies of the species within the specific area and by species conservation status evaluation is one of the major tools for that (Mace & Lande, 1991). However, it is not necessary that a global conservation status of a species has the same conservation status on regional and local scales. On the other hand, some of the species which are under threat globally, but may not be under threat category on a regional or local scales, and vice-versa (Gardenfors et al., 2001; Rana & Samant, 2010). However, very few studies have been carried out so far in temperate, sub-alpine and alpine regions. Therefore, present study attempts to assess and analyze floristic diversity for threat categories.

2. Material and Methods

2.1. Study area

Present investigation was conducted in the Pangi valley which lies between $33^0$04'56"N latitude to $76^0$20'11"E longitude. The study area covered 1601 $km^2$and falls between 2,100-6,200 m amsl. The valley is sandwiched between Pir Panjal and Great Himalayan or Jhanskar Ranges. It is featured with deep river valleys and steep mountain slopes and exhibits temperate, sub-alpine and alpine vegetation. About 68% area falls in sub-alpine and alpine zones and remains snow bound during winter season. The temperature drops below the freezing point at -20^0C and the maximum temperature recorded is about 35^0 C in summer. Annual rainfall is recorded around 200-400mm/year. Valley supports rich storehouse of biodiversity classified into coniferous evergreen temperate forests and deciduous broad-leaved forests, scrubs and herbs of alpine region, supporting a larger number of sensitive biodiversity elements. The Pangi is a remotest valley under the sub-division of District Chamba, well known as the most beautiful high altitude area in the North-western Himalaya. The Chenab is one of the high density water river flowing in narrow gorge and deep in the valley. It originates from Chandratal of Lahaul-Spiti district and enters in to the valley at Karhu Nala. The valley is classified in Purthi, Sach Killar, Kumar-Parmar and Sechu Nala Forest Divisions and known for its beautiful natural, unique, diverse habitats, harsh climatic conditions and rich biodiversity.

Population of Pangi valley is inhabited between 2,100 to 3,500m amsl. The connectivity from Saach Pass (4,500 m amsl) is open for traffic from mid-June upto October and closed during winter season due to snowbound. The valley is inhabited by Pangwal tribe and Bhotii or Buddhist communities. Mostly Hindus are in majority with some of Bhotii tribes. The people of valley named by "Pangwal" and the high altitude villages are called "Bhatories", also their residents are referred to as "bhotts". These residents are mostly Buddhists and have Mongolian-Tibet culture. Mountains of the valley and adjoining hills near the south side are frequently visited by the migratory Gaddis tribe's and pastoralist along with herds. These migratory herders move to high altitudes between summer with their herds for the search of grazing grounds and alpine meadows and also collect various parts of medicinal, wild edibles, and other commercially important aromatic plants for their earnings. The communities residing in the valley also utilize plants as food/wild edibles, medicines and other commercially important aromatic plants for their earning and sustenance.

2.2. Field surveys, samplings and data collection

Categorization of threatened plant diversity has been done on scale index i.e., Conservation Priority Index (CPI). The CPI is sum of attributes such as size of the population, nativity, distribution range, endemism, habitat specificity, use values and extraction trends of species by following Samant et al. (1996b) and Rana & Samant (2010) (Table 1.). Those species fulfilling the parameters of the serial number 1 were given 10 marks for each attribute, serial number 2, given 6 marks for each attribute and serial number 3 given 2 marks for each attribute. Those species fulfilling the all attributes of greater grade points result in the greater cumulative values, which fall under least grade point for every attribute resulting of least cumulative values. Those species ≥ 60% CPI value considered under Critically Endangered category; 55–59% value under Endangered; 50–54% value under Vulnerable; 45–49% value under Near threatened and < 45% value considered under Least Concerned category and those species found in the investigated area, but not cited in sampled sites have also been examined for the threat categorization. Categorization of floristic diversity for threat, the state and global level has been done by some workers (Samant et al., 1998a; Rana & Samant, 2010; 2016; Goraya et al., 2013; Sharma et al., 2017).

Table 1
Attributes used for Threat Categorization of species in Pangi Valley of ChambaDistrict

Habitat(s)	Distribution range (m)	Population size (Ind/Location)	Use Pattern	Extraction	Nativity/ Endemism	Marks
Single	< 500	< 250 Ind/ 2 localities	4 &>4	Commercial	Native & Endemic	10
2–3	500-1000m	250–1000 Ind/ 3–5 localities	2–3	Self Use	Native & Endemic	6
> 3	> 1000	> 1000 Ind/ >5 localities	Single	No	Non-native	2

3. Results

3.1. Status and Diversity of Threatened Plants

Total 95 spp. (24 trees; 10 shrubs; 60 herbs and 01 Fern) belonging to 64 genera and 39 families have been identified as threatened plants in Pangi valley (Table 2& Fig.1). Families with maximum number of threatened species were Apiaceae (09 spp., each), Rosaceae Amaryllidaceae and Ranunculaceae (07 species each), Orchidaceae (06 species), Sapindaceae, Berberidaceae, Boraginaceae, Compositae, Caryophyllaceae, Caprifoliaceae, Elaeagnaceae and Pinaceae(03 spp., each), Amarathaceae, Cupressaceae, Gentianaceae, Ephedraceae, Lamiaceae, Liliaceae, Melanthiaceae and Oleaceae (02 spp., each), Athyriaceae, Cannabaceae, Juglandaceae, Phytolacaceae, Plantaginaceae, Papaveraceae, Simaroubaceae, Saxifragaceae, Taxaceae, Ulmaceae and Xanthorrhoeaceae represented one threatened species, each. In the present study, total 781 species assessed for threat categories, of the total, 95 species fallen under different threat categories i.e., 14 species Critically Endangered,18 Endangered, 25 Vulnerable, 38 Near Threatened and other species were under Least Concern category. Out of total, 02 species reported under Critically Endangered category, 07 Endangered, 05 Vulnerable, 02 Near Threatened and remaining species were reported under Least Concern categories in IUCN threatened list. Out of total, 08 species were reported under Critically Endangered,09 Endangered,08 Vulnerable were reported by many researchers in Himachal Pradesh (Table2). Notable **Critically Endangered** species were *Aconitum heterophyllum, Allium humile, A. wallichii, Angelica glauca, Arnebia benthamii, A. euchroma, Fritillaria cirrhosa, Lilium polyphyllum, Paris polyphylla,Picrorhiza kurroa, Pinus gerardiana, Rheumaustrale, Trillium govanianum* and *Taxus wallichiana*; **Endangered** species, *Allium semenovii, A. stracheyi, Bunium persicum, Carum carvi, Chaerophyllum reflexum, Ferula jaeschkeana, Cypripedium himalaicum, Habenaria intermedia, Dactylorhiza*

hatagirea, Corylus jacqemontii, Crataegus songarica, Delphinium denudatum, Elaeagnus rhamnoides, Ephedra gerardiana, Meconopsis aculeata, Polygonatum verticillatum, Sinopodophyllum hexandrum, and Rheum webbianum; **Vulnerable** species, *Allium carolinianum, Amaranthus cruentus, A. hybridus, Aconitum violaceum, Arnebia guttata, Betula utilis, Celtis tetrandra, Cedrus deodara, Diplazium esculentum, Eremurus himalaicus, Aesculus indica, Artemisia maritima, Alnus nitida, Fraxinus hookeri,Juglans regia, Malaxis muscifera, Platanthera edgeworthii, Polygonatum cirrhifolium, Selinum wallichianum, Valeriana hardwickii, V. jatamansi and Ulmus villosa;* ***Near-Threatened*** *species, Aconitum rotundifolium, Acer acuminatum, A. cappadocicum, Abies spectabilis, Ailanthus altissima, Ajuga integrifolia, A. parviflora, Berberis aristata, B. lycium, Dianthus angulatus, Delphinium brunonianum, D. cashmerianum, D. vestitum, Ephedra intermedia, Fraxinus xanthoxyloides, Herminium monorchis, Gentiana algida, G. kurroo, Hippophae salicifolia, H. tibetana, Juniperus indica, J. polycarpos, Morina longifolia, Phytolacca acinosa,Pleurospermum angelicoides, Prunus armeniaca, P. cornuta, P. persica, Prunus cerasoides, Rosa sericea, Rubus paniculatus, Saussurea obvallata, S. gossypiphora, Silene vulgaris, S. indica var. edgeworthii, Selinum coniifolium, Picea smithiana, Bergenia ciliata and Rubus cochin chinensis* for Pangi valley and all other species were under the Least Concern category (Table 2).

3.2 Altitudinal Distribution

Present study revealed that, of the 95 threatened species, maximum 75 species were identified between **2801 and 3800m.** Some of the notable threatened species found in this zone were *Dactylorhiza hatagirea, Ephedra gerardiana, Eremurus himalaicus*, *Angelica glauca, Aconitum heterophyllum, Trillium govanianum, Carum carvi, Chaerophyllum reflexum, Rheum australe,* etc., followed by 63 spp. between **2100 and 800m,** some notable threatened species are *Corylus jacquemontii, Diplazium esculentum, Bunium persicum, Crataegus songarica*, *Juglans regia, Pinus gerardiana,*etc. and minimum 31species were identified **>3800m** zone**,** and some notable threatened specieswere *Allium humile, A. seminovii, Arnebia benthamii,Picrorhiza kurroa, Ephedra gerardiana, Rheum australe,* etc,(Table 2 & Fig.2).

3.3. Habitat wise Distribution

Habitat wise distribution of threatened species showed that, of the95 species, maximum 72 species were distributed in Dry habitat, followed by Rocky habitat,60 species, Bouldary habitat, 51 species, Shady moist habitat,50 species, Dry alpine slope habitat,35 species, Moist alpine slope, 16 speciesDegradedhabitat,14 species, and Riverine habitat (04 spp.), respectively (Table 2 & Fig.3).

Table 2.Status, diversity and distribution of threatened species in Pangi valley ofChamba District, Himachal Pradesh

Taxa	Family	Altitude Range (m)	Life Form	Habitats	No. of Location
Critically Endangered					
Aconitum heterophyllum Wall. ex Royle	Ranunculaceae	3300-4200	H	II, VIII	16,18,22,26 ,34,37
Allium humile Kunth.	Amaryllidaceae	3000-4000	H	VIII	27,28,29,30,31,32
A. wallichii Kunth.	Amaryllidaceae	2600-3300	H	VIII	30,31 32,
Angelica glauca Edgew.	Apiaceae	2300-3000	H	I, IV, V	4,7,8,9,12,15
Arnebia benthamii(Wall. ex G.Don) I.M.John.	Boraginaceae	3200-4000	H	II, VIII	27,29,33,36,38
A. euchroma (Royle) I.M. John.	Boraginaceae	3300-4100	H	II, VIII	26,27,29,33,36,37
Rheum australe D. Don	Polygonaceae	3000-4200	H	VII, VIII	23,28,33,35,38
Fritillaria cirrhosa D.Don	Liliaceae	3000-4200	H	VII, VIII	15,18,20,23,26,29,31,34,36,37,38
Lilium polyphyllum D.Don.	Liliaceae	2200-2600	H	I, IV, V	2,3,5,6
Paris polyphylla Sm.	Melanthiaceae	2100-3000	H	I, IV, V	2,5,7,10,15
Trillium govanianum Wall.ex D.Don	Melanthiaceae	2500-3800	H	I, IV	12,13,18,24,26
Picrorhiza kurroa Royle	Plantaginaceae	3200-4200	H	VII, VIII	31,32,35,36,37,38
Pinus gerardiana Wall.ex Lamb.	Pinaceae	2100-3000	T	I, II, IV, V	14
Taxus wallichiana Zucc.	Taxaceae	2500-3000	T	I, IV, V	8,10,12,19,24,25
Endangered					
Allium semenovii Regel	Amaryllidaceae	3500-4500	H	VII, VIII	26,27,28,29, 37,38
A. stracheyi Baker	Amaryllidaceae	3000-4500	H	II, VIII	34,35,36,37,38
Bunium persicum (Boiss.) B. Fedtsch.	Apiaceae	2100-3200	H	I, II, V, IV,	2, ,4,5,6,7,9,10,11
Carum carvi L.	Apiaceae	2200-3200	H	I, II, IV, V	11,13,19,20,23,24
Chaerophyllumreflexum Aitch.	Apiaceae	2100-3500	H	I, II, V, IV,	1,2,6,7,9,10,11,12,14,15,16,17, 3,4
*Ferula jaeschkeana*Vatke.	Apiaceae	2400-3600	H	I, II, IV, V	8,10,11,12, 14, 6,7
Cypripedium himalaicum Rofle	Orchidaceae	3000-4300	H	IV	17,25,33,37
Habeneria intermedia D.Don	Orchidaceae	2100-2800	H	I, II, IV, V	1,3,5,6
Dactylorhiza hatagirea (D.Don) Soo	Orchidaceae	2800-4000	H	I, II	7,11,14,19,22,24
Corylus jacqemontii Decne.	Betulaceae	2100-3000	T	I, II, IV, III,	1,3,5,6,9,13,15
Crataegus songarica K. Koch	Rosaceae	2100-3000	T	I, II, IV, III,	1,2,4,6,9,13,16
Delphinium denudatum Wall.ex Hk.f. & Th.	Ranunculaceae	2100-2700	H	II, IV, V	1,2,3,4,7,8

Taxa	Family	Altitude Range (m)	Life Form	Habitats	No. of Location
Elaeagnus rhamnoides (L.) A.Nel.	Elaeagnaceae	2100-2600	Sh	I, II	1,4,5,6,8,
Ephedra gerardiana Wall.ex Stapf.	Ephedraceae	3200-4400	Sh	I, II, VII, VIII	16,19,23,26,29,33
Meconopsis aculeata Royle	Papaveraceae	3000-4200	H	II, IV, V, VIII	14,16,18,23,27,31,34,35,38
Polygonatum verticillatum L.	Asparagaceae	2100-3500	H	I, II, IV, V	1,2,5,7,10,15,17, 23,24,26
Sinopodophyllum hexandrum (Royle) T.S.Ying	Berberidaceae	2400-4000	H	I, II, IV, V, VII, VIII	4,6,8,11,16,19,23,26,29,33,36
Rheum webbianum Royle	Polygonaceae	2200-4100	H	I, II, III, IV, V, VIII, VII,	2,6,8,11,16,19,23,28,33,36
Vulnerable					
Allium carolinianum DC.	Amaryllidaceae	2200-3800	H	II, VIII	34,35,36,37
A. caesium Schrenk.	Amaryllidaceae	3500-4300	H	VII, VIII	27,28,2930,31,32
A. jacquemontii Kunth	Amaryllidaceae	3000-4600	H	I, II, VIII	27,28,29,30,31,32
Amaranthus cruentus L.	Amaranthaceae	2100-3000	H	II, VIII	14,15,17,19,24
A. hybridus L.	Amaranthaceae	2100-3000	H	I, II, IV, V, VI	3,4,6,7,9,1,2
Aconitum violaceum Jacquem. ex Stapf	Ranunculaceae	3500-4200	H	II, V, VIII	22,26,31,34,37,38
Arnebia guttata Bunge	Boraginaceae	3500-4500	H	II, VIII	26,27,29,33,36,37
Diplazium esculentum (Retz.) Sw.	Athyriaceae	2100-2700	Fn	I, IV, V	10,11,13
Aesculus indica (Wall. ex Camb.) Hk.	Sapindaceae	2100-3000	T	I, II, III, IV	1,2,8,16,20,24
Artemisia maritima L.	Compositae	2500-3800	H	II, IV, V, VIII	6,8,11,15,16,17,18,20,29,33,38, 1,2
Alnus nitida (Spach.) Endl.	Betulaceae	2100-2700	T	I, II, IV, V,VI	3,6
Betula utilis D.Don	Betulaceae	2700-3800	T	I, VII, VIII	10,12,15,16,17,19,20,21,22,23,24,25,26,27,28,29,30,31,32,34,35,36,
Eremurus himalaicus Baker	Xanthorrhoeaceae	2100-3200	H	IV, V, VI, I, III	4,5,6,7,8,9, 1, 2
Juglans regia L.	Juglandaceae	2100-2800	T	III, IV, VI, I, II	4,5,7,8, 2,1, 3
Malaxis muscifera (Lindl.) O.K.	Orchidaceae	2500-3600	H	II, IV, V	4,7,11,19,24, 31
***Polygonatum cirrhifolium* Wall. ex Royle**	Asparagaceae	2100-3500	H	I, II, IV, V	1,2,5,7,10,15,17,19,23,24,26
Platanthera edgeworthii (Hk.f.ex Collett.) R.K.Gupta*	Orchidaceae	2600-3000		I, II, VII, VIII	7,11,19
Cedrus deodara (Roxb. ex D.D.) G.Don	Pinaceae	2100-3000	T	IV, V, VI, II,I	4,5,6,7,8,9,10,11,19, 3,1
Celtis australis L.	Cannabaceae	2100-2800	T	I, IV, V, II,	2,3,4,5,1

Taxa	Family	Altitude Range (m)	Life Form	Habitats	No. of Location
Fraxinus hookeri Lingelsh	Oleaceae	2100-2800	T	III, IV, V, II,	3, 4,5, 6,7,8, 1,2
Selinum wallichianum (DC.) Raizada & Saxena	Apiaceae	2700-4000	H	II, IV, V, VII, VIII	10,11,13,15,18,22,26,33,37
S. vaginatum C.B. Cl.	Apiaceae	2500-3800	H	II, IV, V, VII	26,28,29,34,36,37
Valeriana hardwickii Wall.	Caprifoliaceae	2100-3600	H	I, II, IV, V	22,25,29,33,37
V. jatamansi Jones	Caprifoliaceae	2100-3600	H	I, II, IV, V	19,25,29,33,37,38
Ulmus villosa Planch.	Ulmaceae	2100-2900	T	IV, V, I	4, 5, 6, 8, 1, 2, 3
Near-Threatened					
Aconitum rotundifolium Kar. & Kir.	Ranunculaceae	3300-5000	H	II, V, VIII	18,22,26,31,34,37
Acer acuminatum Wall. ex D.Don	Sapindaceae	2100-3000	T	I, II, V, IV,	3,4,5, 7, 7, 8, 9, 10, 11, 12,13,1,2,
A. cappadocicum Gledt.	Sapindaceae	2100-3000	T	I, IV, V, II	3,4,5, 7, 7, 8, 9, 10, 11, 12, 14, 13
Abies spectabilis (D.Don) Mirb.	Pinaceae	2800-3600	T	VII,VIII	31,32,33,34
Ailanthus altissima (Mill.)Sw.	Simaroubaceae	2100-3800	T	II	8,9,10, 18
Ajuga integrifolia Buch.-Ham.	Lamiaceae	2100-2600	H	II, IV, V,I	2,3,5,6,1
A. parviflora Benth.	Lamiaceae	2100-2500	H	IV, V, I,II,	2,3,5,1
Berberis aristata DC.	Berberidaceae	2100-3000	Sh	II, III, IV,I	4,6,7,9,10,11,15,1
B. lycium Royle	Berberidaceae	2100-2500	Sh	II, III, IV, I	4,6,7,8, 1
Dianthus angulatus Royle	Caryophyllaceae	2100-3000	H	II	1,3,5,6,7,8,12,15
Delphinium brunonianum Royle	Ranunculaceae	2600-4000	H	II, IV, V, VIII	17,22,26,31,33,35
D. cashmerianum Royle	Ranunculaceae	2700-4200	H	II, IV, V, VIII	17,22,26,31,33,35
D. vestitum Wall.ex Royle	Ranunculaceae	2500-4000	H	IV, V, VIII	17,22,26,31,35
Ephedra intermedia Schrenk & C.A.Mey.	Ephedraceae	3100-4300	Sh	I, II, VII, VIII	16,19,23,26,29,33,36
Fraxinus xanthoxyloides (G.D.) Wall.ex A.DC.	Oleaceae	2100-3000	T	IV, V, II, III	4, 5,6,7,8, 9,12, 14, 2, 1, 3
Herminium monorchis (L.) R.Br.	Orchidaceae	3000-4300	H	I, II, VII, VIII	15,19,24, 31,35
Gentiana algida Pall.	Gentianaceae	3800-4300	H	II, VIII	30,31,33,35,36
G. kurroo Royle	Gentianaceae	2100-2700	H	IV, V, II	3,4,5,6,7, 1
Hippophae salicifolia D.Don	Elaeagnaceae	2100-2800	T	II, III, IV	1,5,6,8,11,13
H. tibetana Schltdl.	Elaeagnaceae	3000-3800	Sh	II, III, IV	14,18,23,26,29,32,35,37,38
Juniperus indica Bertol.	Cupressaceae	3600-4800	Sh	II, IV, V	19,22,25,28,31,35

Taxa	Family	Altitude Range (m)	Life Form	Habitats	No. of Location
J. polycarpos K.Koch	Cupressaceae	2500-3800	T	II, IV, V	19,22,25,28,31,35
Morina longifolia Wall.ex DC.	Caprifoliaceae	3000-3850	H	IV, V, VIII	15,19,23,27,31
Phytolacca acinosa Roxb.	Phytolacaceae	2200-3200	H	I, II	6,9,13,16
Pleurospermum angelicoides (Wall. ex DC.)Benth.ex C.B. Cl.	Apiaceae	2500-3400	H	II, IV, V	5,6,7,9,11,22
Rubus paniculatus Sm.	Rosaceae	2100-2800	Sh	II, IV, V	1,2,4,6,8
R. cochinchinensis Tratt.	Rosaceae	2100-2700	Sh	II, IV, V	1,2,4,6,8
Prunus armeniaca L.	Rosaceae	2100-2800	T	I, II, III	1,2,4,6,8
P. cornuta (Wall. ex Royle) Steud.	Rosaceae	2200-3000	T	I, II, III	2,4,6,8,13,16
P. persica (L.) Batsch	Rosaceae	2100-3300	T	I, II, III	1,2,4,6,8,13,16,18
P. cerasoides D.Don	Rosaceae	2100-2700	T	I, II	1,2,4,6,8
Rosa sericea Lindl.	Rosaceae	2100-3800	Sh	I, II, IV, V	1,2,8,13,16,18,22,29,35,38
Saussurea obvallata (DC.) Edgew.	Compositae	3600-4500	H	I, VII	33,34,35,36,37,38
S. gossypiphora D.Don	Compositae	3800-4200	H	II, VIII	29,31,33,34,35,36,37,38
Silene vulgaris (Moench) Garcke	Caryophyllaceae	2400-3000	H	II, IV	5,6,7,11,15,19,23,27
S. indica var. *edgeworthii* (Bocquet) Y.J. Nasir	Caryophyllaceae	2100-3000	H	II, IV	1,2,5,6,7,11,15,19,23,27,31
Selinum coniifolium Benth. & Hk. f.	Apiaceae	3200-4000	H	II, IV, V, VII, VIII	5,6,8,11,14,15
Picea smithiana (Wall.) Boiss.	Pinaceae	2100-2600	T	I, IV, V, VI	2,8
Bergenia ciliata (Haw.) Sternb.	Saxifragaceae	2100-2500	H	I, IV, V	2,3,4,5,6,7

Abbreviations used: **T=** tree; **Sh=** shrub; **H=**Herb; **F=** Fern; **Lf=** Leaf; **Bk=** Bark; **Wp=** Whole Plant; **Fl=** Flower; **Fr=** Fruit; **Sd=** Seed; **Wd=** Wood; **Inf=** Inflorescene; **St=** Stem; **Frd=** Frond; **AP=**Aerial part; **Rh=** Rhizome; *= Near Endemic; **= Endemic; **I=**Shady moist; **II=**Dry; **III=**Degraded; **IV=**Rocky; **V=**Bouldary; **VI=** Riverine; **VII=**Moist alpine slope; **VIII=**Dry alpine slope; **1=** Chehri; **2=**Bambal; **3=** Sach-Gharat; **4=** Phindru; **5=**Tiyelu; **6=** Sach; **7=** Sechu; **8=**Purthi; **9=**Kuthal; **10=** Par; **11=**Kulal; **12=**Mohjhi; **13=**Hillor; **14=** Luj-Dharwas; **15=**Than; **16=**Kuthal-Dhar; **17=**Than–Dhar; **18=**Ghesal Dhar; **19=**Kumar-Parmar; **20=**Hudan; **21=**Kulal-Dhar; **22=**Hariyun-Dhar; **23=**Chasak; **24=**Hillu-Tuan; **25=**Sach-Dhar; **26=**Mohjhi-Dhar; **27=** Bahe; **28=**Sural-Bhatori; **29=**Hudan-Bhatori; **30=**Singhmarh; **31=**Mohjhi-Top; **32=**Hillu-Dhar; **33=**Hait-Top; **34=**Chasak Bhatori; **35=**Parmar-Bhatori; **36=**Murch; **37=** Sural Dhar; **38=** Hudan-Dhar; **CE**=Critically Endangered; **EN**=Endangered; **VU**=Vulnerable; **NT**=Near Threatened; **DD**=Data Deficient; **R**=Rear; **HD**=Habitat Degradation; **OE**=Over Exploitation; **IUCN**=International Union for Conseravtion of Nature; **RDB**=Red Data Book; and **HP**=Himachal Pradesh.

4. Discussion

Extinction is the most irreversible phenomenon of all the major environmental calamities happened on earth crust. The recent estimated species extinction rate is about 1,000 and 1,00,000 greater than the natural average extinction rate within the last billions of years. Since the time of speciation and evolution, many species have been lost from their natural habitats and many more are likely to be lost in near future within a short period of geological time scale(Pereira et al., 2010; Barnosky et al., 2011).In the IHR, floristic diversity including native, endemic and threatened species varies with altitude, habitat to habitat, aspect to aspect, and community to community (Samant et al., 2015). Destruction of habitat, unsustainable use and overexploitation of natural species are three major factors responsible to the decline in species richness and population size (Samant et al., 1998b).Various national and international investigations indifferent zones of the world as well Himalayan Region estimates that, we are entered into the mass extinction phase (Myers, 1990), also about half surface of the habitable earth has been distorted (Daily, 1995 & Singh, 2002),which results in degrading and destroying the natural diverse ecosystems. This has necessitated the threat assessment of floristic diversity at local level. Therefore, considering the importance of this, threat

categorization of floristic diversity of the Pangi valley, Chamba District, Himachal Pradesh in North Western and Western Himalaya at local level has been initiated. The occurrence of 95 threatened plant species distributed under Critically Endangered (14spp.), Endangered (18spp.), Vulnerable (25spp.) and Near Threatened (38spp.) categories and representing 24 trees; 10 shrubs; 60 herbs and 01 Fern indicated the high anthropogenic pressures and extreme environmental conditions. Similar work has been done in other high altitude areas of Himachal Pradesh such as, number of species are comparatively lesser than earlier reported, 254 species Threatened species (Ashok, 2007) and 289 species (Sharma, 2017) reported in Cold Desert Biosphere Reserve. This may be due to relatively cold harsh climatic condition in Cold Desert Biosphere Reserve. Similar trend has also been reported from temperate and sub-alpine forests of the Himalaya such as 107 species in Manali Wildlife Sanctuary (Rana, 2007; Rana & Samant 2010), 152 species in Kais Wildlife Sanctuary (Lal, 2007; Lal & Samant, 2010), 145 species in Great Himalayan National Park (Bodh et al., 2018), 160 species in Kanawar Wildlife Santuary (Kaushalya, 2018) and 113 species in Kalatop Khajjiar Wildlife Sanctuary (Ashish, 2018). Over exploitation and habitat degradation of these species may lead to their rapid population depletion or even extinction from their natural habitats, which alarms for the immediate conservation prioritization needs for these species. Some of the parameters such assize of population, and specificity of habitat, utilization and distribution pattern playa key role for the identification and analysis of threat status.Therefore, for each species, detailed studies on these parameters are essentially required and development of an appropriate management plan for conservation of these threatened species, also habitats monitoring, population assessment by applying standard ecological techniques and evaluation of anthropogenic and natural factors responsible for the habitat degradation and depletion of population of the species are urgently required. In addition, mass multiplications of these species by using in vitro-propagation and conventional methods and establishment under ex-situ and in-situ environmental conditions with the participation of local inhabitants and Forest Department are urgently required. Awareness and educational programmes on the conservation and management of threatened species for the local inhabitants are also essentially required. Therefore, the local inhabitants with the Forest Department need to take the responsibility for the conservation of threatened species.

Declarations

Author Contribution

1. Data Analysis & Paper Writing2. Field Survey, Data collection, Data Analysis & Writing3. Data Analysis

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Figures

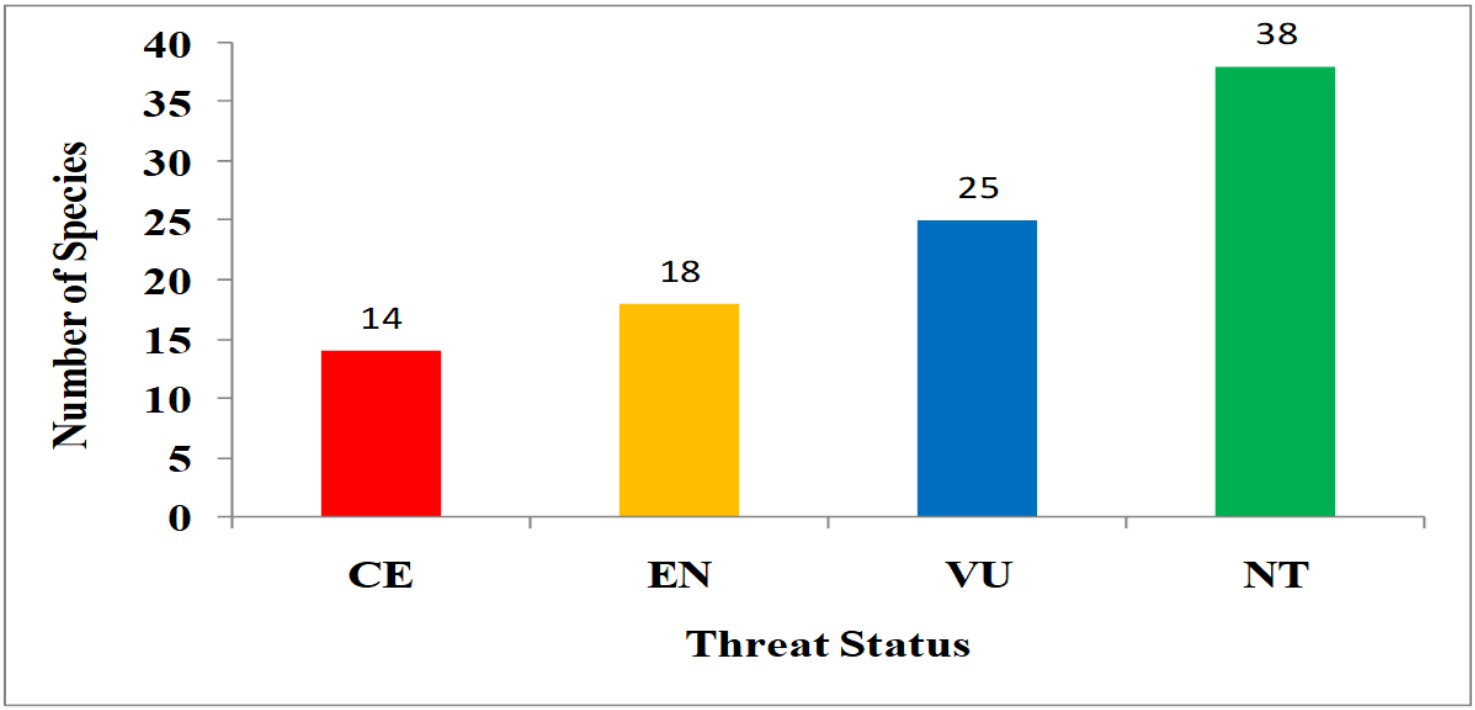

Figure 1

Status and Diversity of threatened plants in Pangi valley of Chamba

District, Himachal Pradesh

Abbreviations used; CE: Critically Endangered; **EN:** Endangered; **VU:** Vulnerable;**NE:** Near Threatened; and **LC:** Least Concerned

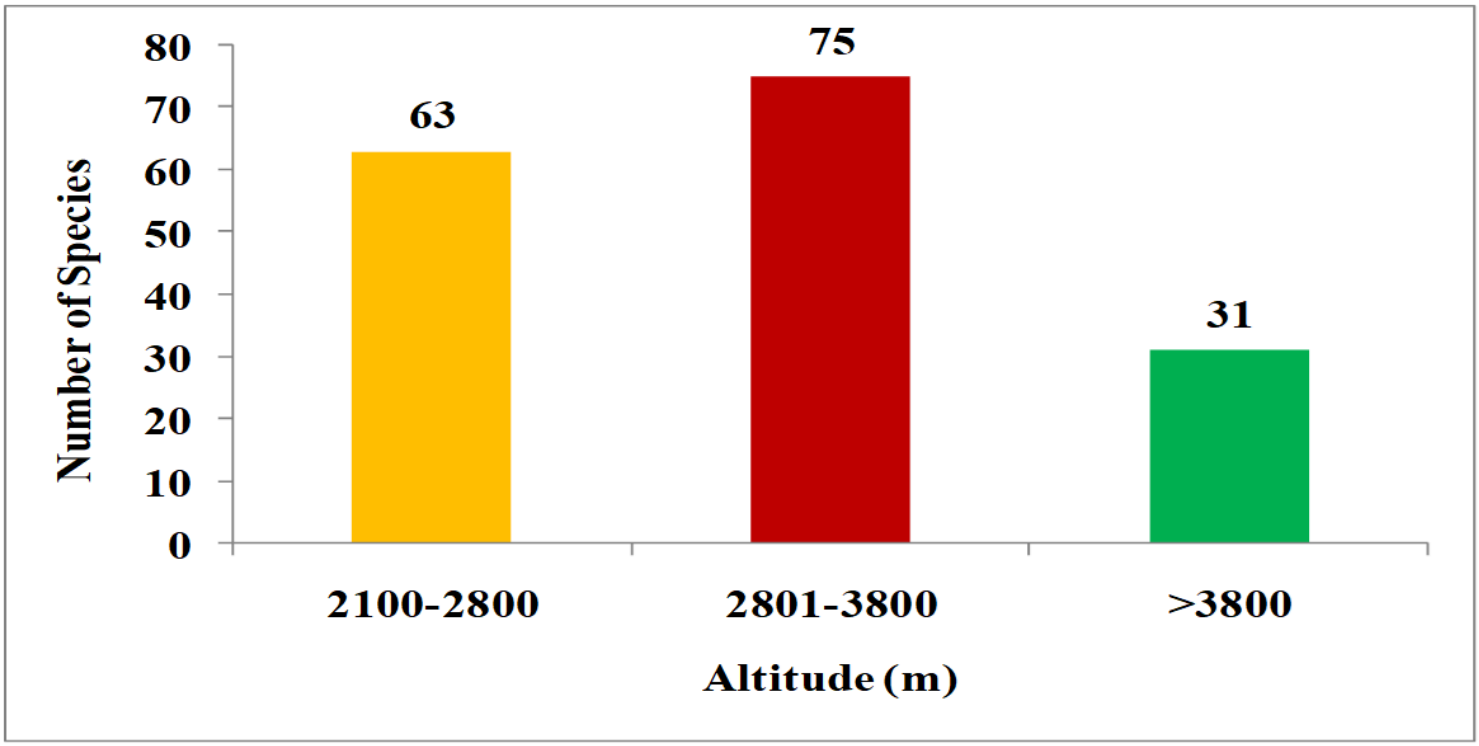

Figure 2

Altitude wise distribution of threatened plants in Pangi valley of Chamba District, Himachal Pradesh

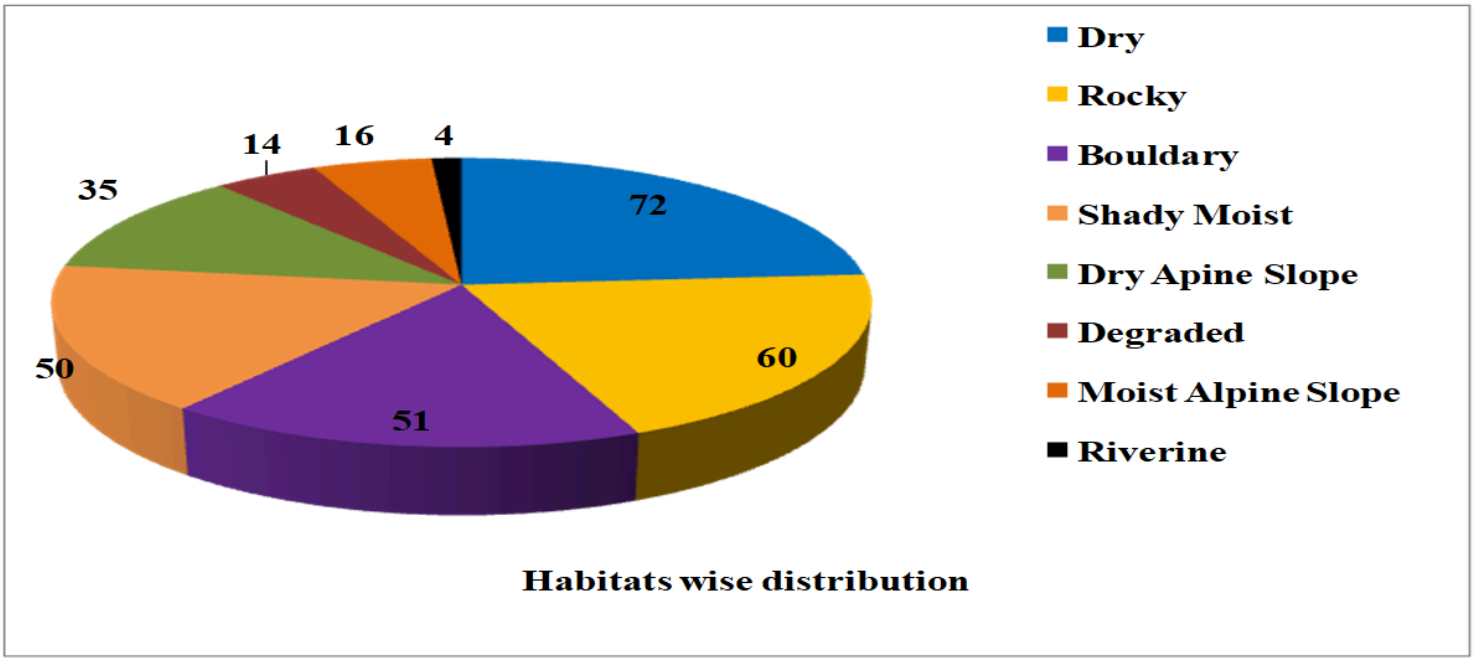

Figure 3

Habitat wise Distribution of Threatened Plants in Pangi valley of Chamba District, Himachal Pradesh

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