



Threat Categorization of Floristic Diversity of Murari Devi and Surrounding Areas in Mandi District of Himachal Pradesh, India

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ABSTRACT: Mountains are home to some of the world's most threatened and endemic species (including medicinal plants), as well as to some of the poorest people, who are dependent on the biological resources. Therefore, present attempt has been made to assess the threat categories of species in Murari Devi and surrounding areas and suggest conservation options. A total 80 species (32 Trees; 28 Shrubs and 20 Herbs) belonging to 68 genera and 46 families have been identified as threatened from Murari Devi and surrounding areas. Thirty one (31) species have been found to be Near Threatened. The remaining species fall under the Least Concern category. Along an altitudinal gradient, the maximum rare endangered species (71 spp.) were distributed in 700-1300m zone, followed by 1301-1800m (09 spp.) zone. Also using new IUCN criteria, 05 species have been categorized as Endangered; Vulnerable (05 spp.) and Least Concern (01 sp.) for Himachal Pradesh and total 03 species; Endangered and Vulnerable (01 sp.) were under global threat categories, whereas 02 species *i.e.*, *Berberis aristata* (Rare) and *Dioscorea deltoidea* (Vulnerable) have been recorded in the Red Data Book of Indian Plants. The overexploitation, habitat degradation and changing environmental conditions may lead to the extinction within a few years. Therefore, regular monitoring of population and habitats, development of conventional protocol, establishment of species in-situ conditions and associated habitats and replication of this approach in other parts of Indian Himalayan Region have been recommended. So that the gene pool of this unique group of plants could be maintained posterity.

Keywords: Threat Categorization; Red Data Book; Medicinal Plants; Overexploitation and Habitat Degradation.

INTRODUCTION: The diversity of life exists on earth and each life form has its own needs for existence. Greater biodiversity leads to greater productivity and greater nutrient retention in ecosystem which leads to greater ecosystem stability.²⁵ Global biodiversity is being lost at an unprecedented rate, as a consequence of human induced environmental change.¹⁵ Since 1966 the International Union for Conservation of Nature and Natural Resources (IUCN) has evaluated species conservation status worldwide and today the IUCN Red Lists have become one of the most important information sources about the conservation status of world's flora and fauna worldwide. Evaluating species conservation status is one of the main tools for establishing conservation priorities and management policies.⁹ A species global conservation status, however, is not necessarily the same as the conservation status on a regional scale. Some species that are threatened on a global scale may not be threatened on a regional scale, and species that are not threatened

on a global scale might be threatened in some part of their range.³ Some species may be declining fast across their ranges on average but may be locally stable or even increasing. Moreover, knowing the regional status of species is important for several reasons. Loss of population and genetic diversity is a major concern.⁴ When a species is protected on a regional scale, conservation of its genetic diversity is promoted.⁵ Regional scale extinction of one species can provoke a cascade of extinctions, causing a change in species composition and in ecosystems processes.⁸ The extinction of a species is the result of local extinctions of its populations.²¹ Clearly, conservation is in need of a method for the assessment of conservation priorities with small data demands, which combines the advantages of red lists and the assessment of international importance of a population. Degradation and fragmentation of >70% of the original habitats placed Himalaya in the list of Global Biodiversity Hotspots.¹⁰ In the IHR, attempts have been

made to identify the threatened plants by various workers.^{2,13,16,22} Under the current scenario, about 20% of all species are expected to be lost within 30 years and 50% or more by the end of 21st century.¹¹

In the IHR, over exploitation and habitat degradation are the two major factors responsible for decrease in population of the species.¹⁷ However, using different parameters of rarity *i.e.*, habitat preference, population size, distribution range and anthropogenic pressure, only few studies have been carried out in some of the protected areas^{6,22} and unprotected areas^{14,19}. In view of the ongoing threats, it is important to identify and prioritize biodiversity elements at local, regional and global levels. As such, threat assessment of all the species of a particular region has been carried out by a very few workers.^{7,19,20} Such studies are essentially required along the altitudinal and across the horizontal gradients of the IHR. Therefore, present attempt has been made to assess the threat categories of species in Murari Devi and surrounding areas and suggest conservation options.

Study area: The study has been carried out in Murari Devi and surrounding areas, situated at a distance of 40 Km in the south-west direction of Mandi on Mandi-Hamirpur highway. This covers the 'Sikandra Dhar' ranges of submontane Himalayas between 31° 37' 30" N latitudes and 76° 49' 50" E longitudes. Murari Devi temple is a beautiful place in the west of Sunder Nagar on the top of a sacred hill named Murari Dhar. It is believed that this temple was made by Pandvas during their "Agyatwaas". The study areas were fall in Suket, Bhambla and Nagrota Forest Division of Mandi District in Himachal Pradesh with an altitudinal range varies from 700 to 2,000 m amsl. Geographically, the area constitutes a part of Mandi (an area formed by the merger of the erstwhile princely states of Mandi and Suket on the formation of Himachal Pradesh on 15 April, 1948). The area is inhabited by a large number of villages *i.e.*, Ukhla, Smaila, Plassi, Kot, Baldwara, Bhambla, Sikandra, Bachawan, Kasmela, Math, Bhated, Balra, Alsogi, Chowk, Amblagal, Kalkhar, Katoh, Badoun, Dabhoi, Trifalghat, Ropadi, Leda, etc. The area is well known for its diverse habitats and rich biodiversity being dominated by tropical, sub-tropical, temperate and sub-alpine broad leaved and coniferous forests, and supports a large number of sensitive biodiversity elements including medicinal and aromatic plants, wild edibles, rare endangered, native and wild relatives of crop plants. Agriculture and Horticulture are the amongst major livelihood options of the villages. However, to a considerable extent, the villagers augment their income from agriculture, by rearing sheep

and goats for wool and meat and by extracting medicinal plants. Extraction of medicinal herbs and collection of wild edibles has been their traditional source of income generation.

The geology of the area is varied. The area comprises of Granite Gneiss, Leucogranite, Phyllite, Quartzite, Minor Limestone, Pebbly Quartzite, Slate, Grit, Streaky and Banded Gneisses, and Schists. The two chief types of rocks of the area are Gneissic rocks, Shales and Slates which fall under Mandi Granitoid Complex and are composed of granites of varied compositions and textures. These are Prophyroblastic Granite Gneiss, Biotite Granite, Muscovite Granite and Leucogranites. These granites are mainly composed of Quartz, Feldspar and Mafics.

Climate: The district represents a subtropical highland climate under the Koppen climate classification. The climate of the district is composite having hot summers and cold winters. Usually, four different seasons represent the area, *i.e.*, winter (Mid-December to February), summer (March to June), rainy (July to Mid-September), autumn (October to November). Winter is calm in low down areas, while it snows on high peak ranges. Springs are warm and fair. Rainy season is the wettest part of the year and characterized by high humidity. Summers are itchy and hot throughout the monsoon periods.²⁴ Temperature typically ranges from 6°C to 41°C over the course of a year. The average temperature during summer is between 18.9°C and 39.6°C and between 6.7°C and 26.2°C in winter. Monthly precipitation varies between 25.4 mm in November to 228.6 mm in August. It is typically around 58.3 mm per month during winter and spring and around 101.6 mm in June as the monsoon approaches. The average total annual precipitation is 1,092.2 mm, which is much less than most other hill stations but still greatly heavier than on the plains. Snowfall in the region, which historically has taken place few years back is now very rare or no due to increasing temperature and global warming.

Vegetation: Flora and Fauna: The altitudinal sprawls, as well as climatic and pedological conditions of this area have resulted into highly diversified vegetation. The distribution of different species follows fairly regular altitudinal stratification. The vegetation comprises of tropical, sub-tropical, temperate and sub-alpine broad leaved and coniferous forests and supports a large number of sensitive biodiversity elements including medicinal and aromatic plants, wild edibles, rare, endangered, native, endemic and wild relatives of crop plants. The subtropical forests (1300-1800m) are characterized by; (i) evergreen

coniferous forests mainly of *Pinus roxburghii*; and (ii) evergreen broad leaved forests of *Myrica esculenta*, *Quercus leucotrichophora*, *Q. glauca* and *Rhododendron arboreum*. The temperate forests (1800-2800m) are characterized by; (i) broad leaved deciduous forests comprising of *Acer cappadocicum* and *A. acuminatum*, etc.; (ii) evergreen forests dominated by coniferous forests i.e., *Cedrus deodara* and *Pinus wallichiana*; and (iii) evergreen broad leaved forests of *Ilex diyprena* and *Ilex excelsa*, etc. Sub-alpine forests (>2800m) are characterized mainly by; (i) evergreen broad leaved forests mainly of *Quercus semecarpifolia*; and (ii) coniferous forests of *Abies pindrow* and *Taxus baccata* subsp. *wallichiana*. The forest types support a large number of biodiversity elements.

Besides, the area is bestowed with varied landscape features that provide large number of habitats to a diverse group of faunal types, there is a good diversity of mammals, reptiles and avian fauna, including the Indian National Bird, *Pavo cristatus* L. The main animals are Leopard (*Panthera pardus* L.), Himalayan Black Bear (*Selenarctos thibetanus* Cuvier), Jungle cat (*Felis chaus* Guld.), Wolf (*Canis lupus* L.), Indian Fox (*Vulpes bengalensis* Shaw), Himalayan Pine Mar-

tin (*Martes flavigula* Bodd.) and Indian Porcupine (*Hystrix indica* Kerr.) Amongst the birds, Blue Rock Pigeon (*Columba intermedia* Srickl.), Dove (*Streptopelia decaocto* Lath.), Jungle Myne (*Acridotheres fuscus* Wangl.), Kaleej Pheasant (*Lophura leucomelanos* Lath.), Cheer Pheasant (*Catreus wallichii* Hardw.), etc. Besides these, Woodpeckers, Parakeets and in reptiles, snakes are of common occurrence.

MATERIALS AND METHODS: Different attributes such as habitat specificity, population size, distribution range, use values, extraction, nativity and endemism of the taxa have been used for the threat categorization of the floristic diversity^{20,26}. The attributes used were divided into three grades; highest (10 marks); subsequent (6 marks) and least (2 marks). The species fulfilling all the attributes in highest grade resulted in highest cumulative values and one which falls in least grade for every attribute resulted in least cumulative values. The species having >70% score were considered as Critically Endangered; 60-69% as Endangered; 50-59% as Vulnerable; and 40-49% as Near threatened, whereas <45% were considered as Least Concern.

Table 1: Parameters used for the threat categorization of floristic diversity.

Points/ Scores	Altitudinal Range (m)	H/ Hs	Use Values	Population Size	Native & Endemic	Extraction
10	<500	2	> 4	250 Ind/2 locations	Native & Endemic	Commercial
6	500-1000	3-4	3-4	1000 Ind/3-5 location	Native/Endemic	Self Use
2	>1000	>4	<3	>1000 Ind/>5 locations	Non-native	No Extraction

Abbreviations Used: H/Hs=Habitat/(s); and m=Meter

Categorization of these species for the State and globally as Critically Endangered, Endangered, Vulnerable, etc., has also been done²⁶. The species, which occurred in the area but not cited in the sampled sites have also been considered for categorization.

RESULTS:

Diversity of threatened species: Of the total species recorded, 80 species (32 Trees; 28 Shrubs & 20 Herbs) belonging to 68 genera and 46 families have been identified as threatened from Murari Devi and surrounding areas. Thirty one (31) species have been found to be Near Threatened. The remaining species fall under the Least Concern category.

Altitudinal distribution: Along an altitudinal gradient, the maximum rare endangered species (71 spp.) were distributed in 700-1300m zone, followed by 1301-1800m (09 spp.) zone (Figure 1).

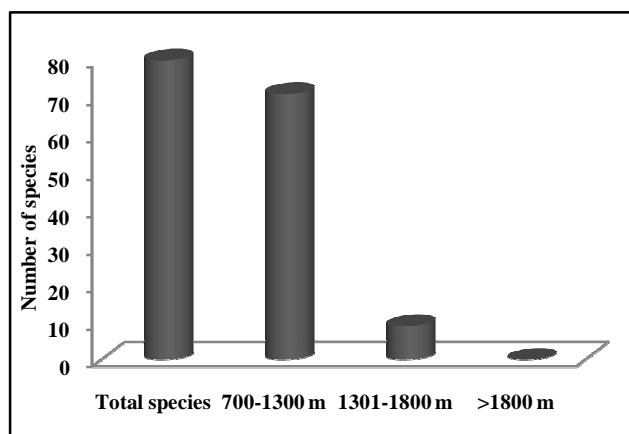


Figure 1: Altitudinal distribution of threatened plants in Murari Devi and surrounding areas of Mandi district in Himachal Pradesh, India.

Threat Categorization: In the present study, of the total species, 09 species were identified as Critically Endangered, 16 species as Endangered; 24 species as

Vulnerable; 31 species as Near Threatened and remaining species as Least Concern based on threat categorization score. Some of the notable **Critically Endangered** species are *Azadirachta indica*, *Pistacia integerrima*, *Terminalia bellirica*, *T. chebula*, *Elaeagnus conferta*, *Juglans regia*, *Zanthoxylum armatum*, etc., **Endangered**, *Acorus calamus*, *Asparagus adscendens*, *Justicia adhatoda*, *Deeringia amaranthoides*, *Bauhinia vahlii*, *Melothria heterophylla*, *Dioscorea deltoidea*, *Albizia julibrissin*, *Butea monosperma*, *Ougeinia oojainensis*, *Cinnamomum tamala*, *Morus alba*, *Syzygium cumini*, *Habenaria marginata*, *Rosa brunonii*, *Valeriana jatamansi*, etc., **Vulnerable**, *Asparagus racemosus*, *Inula cappa*, *Bombax ceiba*, *Rhododendron arboretum*, *Embllica officinalis*, *Lespedeza gerardiana*, *Mucuna pruriens*, *Quercus leucotricophora*, *Hedychium spicatum*, *Hypericum oblongifolium*, *Salvia lanata*, *Nepeta hindostana*, *Acacia catechu*, *Ficus nemoralis*, *Myrica esculenta*, *Cedrus deodara*, *Plantago ovata*, *Zizyphus oxyphylla*, *Murraya koenigii*, *Aegle marmelos*, *Murraya paniculata*, *Bergenia ligulata*, *Vitex negundo*, etc., **Near Threatened**, *Lannea coromandelica*, *Sauromatum venosum*, *Phoenix humilis*, *Elephantopus scaber*, *Berberis lycium*, *Buddleja crispa*, *Bauhinia racemosa*, *Cyanotis cristata*, *Dioscorea bulbifera*, *Euphorbia royleana*, *Millettia auriculata*, *Dalbergia sissoo*, *Flacourtia indica*, *Salvia nubicola*, *Roylea cinerea*, *Reinwardtia indica*, *Osbeckia stellata*, *Tinospora cordifolia*, *Albizia chinensis*, *Pinus roxburghii*, *Pyrus pashia*, *Leptodermis lenceolata*, *Boenninghausenia albiflora*, *Helicteres isora*, *Symplocos chinensis*, *Grewia asiatica*, etc., for Murari Devi and surrounding areas.

Also using new IUCN criteria, 05 species have been categorized as **Endangered**; **Vulnerable** (05 spp.) and Least Concern (01 sp.) for Himachal Pradesh and total 03 species; **Endangered** and **Vulnerable** (01 sp.) were under global threat categories, whereas 02 spe-

cies i.e., *Berberis aristata* (**Rare**) and *Dioscorea deltoidea* (**Vulnerable**) have been recorded in the Red Data Book of Indian Plants¹² (Table 2).

Habitat wise distribution: In general, 66 species were reported from the dry, 60 species in shady moist, 58 species degraded, 48 species in bouldary, 33 species in riverine, 20 species in shrubbery, 18 species in near crop field/cultivated field, 15 species in waste places/road side, 14 species in rocky and 07 species in Water courses/marshy places. Habitat wise distribution of species in the study area showed that one species i.e., *Sauromatum venosum* was distributed in one habitat only, 09 species in two habitats, whereas 17 species were distributed in three habitats and 53 species in >3 habitats. Among the species, *Syzygium-cumini*, *Berberis lyceum* (08 habitats); *Embllica officinalis*, *Juglans regia*, *Roylea cinerea* and *Zanthoxylum armatum* (07 habitats); *Aegle marmelos*, *Vitex negundo*, *Murraya koenigii* and *Murraya paniculata* (06 habitats); *Albizia chinensis*, *Buddleja crispa*, *Euphorbia royleana*, *Phoenix humilis*, *Hedychium spicatum*, *Hypericum oblongifolium*, *Helicteres isora*, *Pinus roxburghii*, *Tinospora cordifolia*, *Quercus leucotricophora*, *Pistacia integerrima*, *Symplocos chinensis*, *Rosa brunonii*, *Pyrus pashia*, *Terminalia bellirica*, *T. chebula*, *Reinwardtia indica*, *Bauhinia vahlii*, *Dioscorea deltoidea*, *Butea monosperma*, *Asparagus racemosus* and *Rhododendron arboreum* (05 habitats, each); *Boenninghausenia albiflora*, *Berberis aristata*, *Elaeagnus parviflora*, *Azadirachta indica*, *Albizia julibrissin*, *Morus alba*, *Mucuna pruriens*, *Nepeta hindostana*, *Acacia catechu*, *Cedrus deodara*, *Plantago ovata*, *Zizyphus oxyphylla*, *Z. rugosa*, *Lannea coromandelica*, *Elephantopus scaber*, *Millettia auriculata*, *Dalbergia sissoo*, *Flacourtia indica* and *Salvia nubicola* (04 habitats, each) represented the maximum habitats (Table 2).

Table 2: Diversity, distribution pattern and status of the threatened plants in Murari Devi and surrounding areas of Himachal Pradesh, India.

Taxa/Threat Category	Family	AR (m)	Habitat/s	HF	Status			Threat
					HP	GB	RD	
Critically Endangered								
<i>Pistacia integerrima</i> Bin	Anacardiaceae	700-1800	1, 2, 3, 4, 5	T	-	-	-	OE, HD
<i>Berberis aristata</i> DC.*	Berberidaceae	1000-2000	1, 2, 3, 4	Sh	EN	EN	R	OE, HD
<i>Terminalia bellirica</i> (Gaertn.) Roxb	Combretaceae	700-1300	1, 2, 3, 4, 5	T	-	-	-	OE, HD
<i>T. chebula</i> Retz.	Combretaceae	700-1500	1, 2, 3, 4, 5	T	-	-	-	OE, HD
<i>Elaeagnus conferta</i> Roxb.*	Elaeagnaceae	1200-1900	3, 4, 7	Sh	-	-	-	HD
<i>E. parviflora</i> Wall. Ex Royle	Elaeagnaceae	1400-2000	1, 3, 4, 5	Sh	-	-	-	HD
<i>Juglans regia</i> L.*	Juglandaceae	700-2000	1, 2, 3, 4, 5, 8, 9	T	-	-	-	OE, HD
<i>Azadirachta indica</i> L.	Meliaceae	700-1100	1, 3, 4, 5	T	-	-	-	OE, HD
<i>Zanthoxylum armatum</i> DC.	Rutaceae	900-1900	1, 2, 3, 4, 5, 7, 9	Sh	EN	-	-	OE, HD

Endangered								
<i>Justicia adhatoda</i> L.	Acanthaceae	700-1300	1, 3, 5	Sh	-	-	-	OE, HD
<i>Deeringia amaranthoides</i> (Lam.) Merr.	Amaranthaceae	700-1200	3, 4, 5	Sh	-	-	-	HD
<i>Acorus calamus</i> L.	Araceae	1000-1800	1, 10	H	-	-	-	OE, HD
<i>Asparagus adscendens</i> Roxb.	Asparagaceae	700-1400	1, 2	H	-	-	-	HD
<i>Bauhinia vahlii</i> (Wt. & Arn.) Benth.	Caesalpiniaceae	700-1200	1, 2, 3, 4, 5, 6, 9	Sh	-	-	-	OE, HD
<i>Melothria heterophylla</i> (Lour.) Cogn.	Cucurbitaceae	1100-1700	1, 3, 4	H	-	-	-	HD
<i>Dioscorea deltoidea</i> Wall. ex Kunth	Dioscoreaceae	800-2000	1, 4, 5, 6, 7	H	EN	EN	VU	OE, HD
<i>Albizia julibrissin</i> Durazz	Fabaceae	700-1500	3, 4, 5, 9	T	-	-	-	OE, HD
<i>Butea monosperma</i> (Lamk.) Taub.	Fabaceae	700-1200	1, 3, 4, 8, 9	T	-	-	-	OE, HD
<i>Ougeinia oojeinensis</i> (Roxb.) Hochr.	Fabaceae	700-1200	3, 4, 5	T	-	-	-	HD
<i>Cinnamomum tamala</i> Nees & Ebern*	Lauraceae	700-1500	1, 2, 9	T	VU	-	-	OE, HD
<i>Morus alba</i> L.	Moraceae	700-1000	1, 3, 4, 5	T	-	-	-	HD
<i>Syzygium cumini</i> Skees	Myrtaceae	700-1500	1, 3, 4, 5, 6, 7, 8, 9	T	-	-	-	OE, HD
<i>Habenaria marginata</i> Hk.f. ex Collett	Orchidaceae	700-2000	1, 2	H	EN	EN	-	HD
<i>Rosa brunonii</i> Lindl.	Rosaceae	700-2000	1, 2, 4, 5, 7	Sh	-	-	-	HD
<i>Valeriana jatamansi</i> Jones	Valerianaceae	1500-2000	1, 2	H	VU	-	-	OE, HD
Vulnerable								
<i>Asparagus racemosus</i> Willd.	Asparagaceae	700-2000	1, 2, 3, 4, 9	Sh	-	-	-	HD
<i>Inula cappa</i> (Buch.-Ham. ex D. Don) DC.	Asteraceae	1000-1900	1, 7, 9, 10	Sh	-	-	-	HD
<i>Bombax ceiba</i> L.	Boraginaceae	700-1700	2, 3, 4, 5, 6, 9	T	-	-	-	HD
<i>Rhododendron arboreum</i> Sm.	Ericaceae	1600-2000	1, 2, 4, 5, 6	T	-	-	-	OE, HD
<i>Emblica officinalis</i> L.	Euphorbiaceae	700-2000	1, 3, 4, 5, 6, 8, 9	T	-	-	-	OE, HD
<i>Lespedeza gerardiana</i> Grah. ex Maxim.*	Fabaceae	1200-2000	3, 4, 5	H	-	-	-	HD
<i>Mucuna pruriens</i> (L.) DC.	Fabaceae	700-1100	3, 4, 5, 7	Sh	-	-	-	HD
<i>Quercus leucotricophora</i> A. Camus	Fagaceae	1200-2000	1, 2, 4, 5, 6, 7, 8	T	-	-	-	OE, HD
<i>Hypericum oblongifolium</i> Choisy*	Hypericaceae	1000-2000	1, 2, 4, 5, 9	Sh	VU	-	-	OE, HD
<i>Salvia lanata</i> Roxb.*	Lamiaceae	1500-2000	1, 2, 4	H	-	-	-	HD
<i>Nepeta hindostana</i> B. Heyne	Lamiaceae	700-1100	1, 3, 4, 5	H	-	-	-	HD
<i>Acacia catechu</i> (L.f.) Willd.	Mimosaceae	700-1000	3, 4, 5, 6	T	-	-	-	OE, HD
<i>Ficus nemoralis</i> Wall. ex Mir	Moraceae	1500-2000	4, 5, 7	T	-	-	-	OE, HD
<i>Myrica esculenta</i> Buch.-Ham. ex Don	Myricaceae	1400-2000	1, 2, 4	T	-	-	-	OE, HD
<i>Cedrus deodara</i> (Roxb. ex D. Don) G. Don*	Pinaceae	1600-2000	1, 3, 4, 5	T	-	-	-	OE, HD
<i>Plantago ovata</i> Forssk.	Plantaginaceae	1600-2000	1, 3, 4, 5	H	-	-	-	OE, HD
<i>Zizyphus oxyphylla</i> Edgew.	Rhamnaceae	700-1100	3, 4, 5, 7	Sh	-	-	-	OE, HD
<i>Z. rugose</i> Lamk.	Rhamnaceae	700-1000	2, 3, 4, 7	Sh	-	-	-	HD
<i>Murraya koenigii</i> (L.) Spr.	Rutaceae	700-1400	1, 3, 4, 5, 7, 8	Sh	-	-	-	HD
<i>Aegle marmelos</i> (L.) Corr.	Rutaceae	700-1200	2, 3, 4, 5, 8, 9	T	-	-	-	HD
<i>Murraya paniculata</i> (L.) Jack	Rutaceae	700-1000	1, 3, 4, 6, 7, 9	Sh	-	-	-	HD

<i>Bergenia ligulata</i> (Wall.) Engl. *	Saxifragaceae	1000-1800	1, 6, 10	H	-	-	-	HD
<i>Vitex negundo</i> L.	Verbenaceae	700-1600	2, 3, 4, 7, 8, 9	Sh	-	-	-	HD
<i>Hedychium spicatum</i> Sm.*	Zingiberaceae	700-2000	1, 2, 8, 9, 10	H	VU	-	-	OE, HD
Near Threatened								
<i>Lansea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	700-1400	1, 3, 4, 5	T	-	-	-	HD
<i>Sauromatum venosum</i> Kunth.	Araceae	1000-2000	1	H	-	-	-	HD
<i>Phoenix humilis</i> Royle	Araceae	700-1700	2, 3, 4, 5, 6	Sh	-	-	-	HD
<i>Elephantopus scaber</i> L.	Asteraceae	700-1600	1, 3, 4, 5	H	-	-	-	HD
<i>Berberis lyceum</i> Royle*	Berberidaceae	700-2000	1, 3, 4, 5, 6, 7, 8, 9	Sh	EN	-	-	OE, HD
<i>Buddleja crispa</i> Benth.	Buddlejaceae	1400-1900	3, 4, 5, 7, 8	Sh	-	-	-	HD
<i>Bauhinia racemosa</i> Lamk.	Caesalpiniaceae	700-1000	1, 3, 4	T	-	-	-	OE, HD
<i>B. retusa</i> Roxb.	Caesalpiniaceae	700-1000	1, 3	T	-	-	-	HD
<i>Cyanotis cristata</i> (L.) Don	Commelinaceae	700-2000	1, 2, 4	H	-	-	-	OE, HD
<i>Cyperus compressus</i> L.	Cyperaceae	700-2000	3, 10	H	-	-	-	OE, HD
<i>C. squarrosus</i> L.	Cyperaceae	700-1700	9, 10	H	-	-	-	HD
<i>Dioscorea bulbifera</i> L.	Dioscoreaceae	700-2000	1, 4	H	-	-	-	HD
<i>Euphorbia royleana</i> Boiss.	Euphorbiaceae	700-2000	1, 2, 3, 4, 5, 8	Sh	-	-	-	HD
<i>Millettia auriculata</i> (Benth.) Baker	Fabaceae	700-1100	1, 3, 4, 5	Sh	-	-	-	HD
<i>Dalbergia sissoo</i> Roxb.	Fabaceae	700-1300	3, 4, 5, 8	T	-	-	-	OE, HD
<i>Flacourtia indica</i> (Burm.f.) Merr.	Flacourtiaceae	700-1000	1, 3, 4, 5	T	-	-	-	HD
<i>Salvia nubicola</i> Wall.*	Lamiaceae	1300-2000	1, 3, 4, 5	H	-	-	-	HD
<i>Roylea cinerea</i> Baill.	Lamiaceae	700-2000	1, 2, 3, 4, 5, 7, 8	Sh	VU	VU	-	OE, HD
<i>Reinwardtia indica</i> Dum.*	Linaceae	700-2000	1, 2, 4, 7, 10	Sh	-	-	-	HD
<i>Osbeckia stellata</i> Buch.-Ham. ex D. Don	Melastomataceae	1200-2000	1, 3, 4	Sh	-	-	-	HD
<i>Tinospora cordifolia</i> (L.) Merr.	Menispermaceae	700-1300	1, 2, 3, 4, 5	Sh	-	-	-	HD
<i>Albizia chinensis</i> (Osb.) Merr	Mimosaceae	700-1300	2, 3, 4, 5, 8	T	-	-	-	OE, HD
<i>Pinus roxburghii</i> Sarg.*	Pinaceae	700-2000	1, 3, 4, 5, 6	T	-	-	-	OE, HD
<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Rosaceae	700-2000	1, 2, 3, 4, 7	T	-	-	-	HD
<i>Leptodermis lenceolata</i> Wall.	Rubiaceae	700-2000	1, 3, 4	Sh	-	-	-	HD
<i>Wendlandia heynei</i> (Roem. & Schult.) Sant. & Merch.	Rubiaceae	700-1600	1, 3, 4	T	-	-	-	HD
<i>Limonia acidissima</i> L.	Rutaceae	700-1000	1, 6	T	-	-	-	HD
<i>Boenninghausenia albiflora</i> (Hk.f.) Reichb. ex Meissn.	Rutaceae	1300-2000	1, 3, 4, 7	H	-	-	-	HD
<i>Helicteres isora</i> L.	Sterculiaceae	700-1000	1, 2, 3, 4, 5	Sh	-	-	-	OE, HD
<i>Symplocos chinensis</i> (Lour.) Druce	Symplocaceae	1300-2000	1, 2, 3, 4, 5	T	LC	-	-	OE, HD
<i>Grewia asiatica</i> L.	Tiliaceae	700-1100	3, 4, 5	T	-	-	-	OE, HD

Abbreviations used: **=Endemic; *=Near endemic; AR=Altitudinal Range; LF=Life Form; HP=Himachal Pradesh; GB=Global; RD=Red Data Book; T=Tree; Sh=Shrub; H=Herb; Fn=Fern; R=Rare; CR=Critically Endangered; EN=Endangered; VU=Vulnerable; LC=Least Concern; 1=Shady Moist; 2=Riverine; 3=Degraded; 4=Dry; 5=Bouldary; 6=Rocky; 7=Shrubbery; 8=Waste Places/Road Side; 9=Near crop field/Cultivated field; 10=Water courses/marshy places.; OE=Over Exploitation; and HD=Habitat Degradation

DISCUSSION AND CONCLUSION: The Himalayas covers eight countries (i.e., Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, Pakistan, and India) and are supposed to be a rich storehouse of valuable threatened plant species. The Himalayas cover 18% of the Indian subcontinent, account for more than 50% of India's forest, and contain 40% of India's endemic species.²³ The area harbors about 8000 species of angiosperms of which 1748 are used for medicinal purposes.¹⁸ The present scenario, biodiversity crisis is being experienced throughout the globe. Therefore, appropriate conservation actions need to be set up in the most efficient way possible to optimally use limited resources. Unfortunately, none of the available methods of conservation priority setting are widely accepted as their data requirements are too stringent, scientifically unsound, or are too complex for the usage by decision makers. In most of the studies, identification of threatened species has been carried out using qualitative attributes/observations, only. However, assessment of the status of species using standard format including qualitative as well as quantitative attributes has been suggested by few workers¹. Knowing the importance of floristic diversity for the human being, threat categorization at local, regional and global levels are essentially required. Threat categorization at local level would help in developing adequate management plans. In view of this, threat categorization of floristic diversity at local level along an altitudinal and horizontal gradients has been initiated in the IHR. So that based on grass root level information adequate management plan could be developed for the entire IHR and globe.

Habitat specificity, population size, distribution range and use pattern play an important role in identification of status of the species. In the present study, threat assessment of floristic diversity for a particular region has been carried out. On the basis of Threat Categorization Score (TCS), species have been categorized. The more TCS indicates the need for a greater level of attention to local strategies for conservation and management. Categorization of 09 species as Critically Endangered, 16 species as Endangered; 24 species as Vulnerable and 31 species as Near Threatened indicates the high degree of anthropogenic pressure. Some species such as *Azadirachta indica*, *Pistacia integerrima*, *Terminalia bellirica*, *T. chebula*, *Elaeagnus conferta*, *Juglan sregia*, *Zanthoxylum armatum*, *Acorus calamus*, *Bauhinia vahlii*, *Dioscorea deltoidea*, *Cinnamomum tamala*, *Syzygium cumini*, *Valeriana jatamansi*, *Asparagus racemosus*, *Rhododendron arboretum*, *Embllica officinalis*, *Quercus leucotricophora*, *Hedychium spicatum*, *H. oblongifolium*, *Acacia*

catechu, *Myrica esculenta*, *Cedrus deodara*, *Plantago ovata*, *Zizyphus oxyphylla*, *Aegle marmelos*, *Murraya koenigii*, *M. paniculata*, *Bergenia ligulata*, *Vitex negundo*, *Berberis lycium*, *Dalbergia sissoo*, *Flacourtia indica* and *Tinospora cordifolia* showed high threats in the study areas, Himachal Pradesh and throughout the Globe hence have high conservation importance. Land use, climate change, nitrogen deposition, biotic exchange and atmospheric carbon dioxide have been the major cause of changes in biodiversity. Moreover, the climate change is not, at the moment, the major threat affecting plants and it is less important than the change in the land use. Two factors i.e., overexploitation and habitat degradation have been causing decrease in the population of a species throughout globe.³⁸ species were severely affected by both the factors and 41 species were suffering from habitat degradation. Over exploitation of underground parts i.e., roots/rhizomes/barks/tubers/bulbs of *Acorus calamus*, *Dioscorea deltoidea*, *Zanthoxylum armatum*, *Juglans regia*, *Hedychium spicatum*, *H. oblongifolium*, *Acacia catechu*, *Murraya koenigii*, *Vitex negundo*, *Berberis lycium*, *Tinospora cordifolia*, etc. may lead to extinction of these species from their natural habitats. Listing of species like *Berberis aristata* and *Dioscorea deltoidea* in the Red Data Book of Indian Plants indicated priority attention for conservation.

Among the species, *Syzygium cumini*, *Berberis lycium* (08 habitats); *Embllica officinalis*, *Juglans regia*, *Royalea cinerea* and *Zanthoxylum armatum* (07 habitats); *Aegle marmelos*, *Vitex negundo*, *Murraya koenigii* and *Murraya paniculata* (06 habitats); *Albizia chinensis*, *Buddleja crispa*, *Euphorbia royleana*, *Phoenix humilis*, *Hedychium spicatum*, *Hypericum oblongifolium*, *Helicteres isora*, *Pinus roxburghii*, *Tinospora cordifolia*, *Quercus leucotricophora*, *Pistacia integerrima*, *Symplocos chinensis*, *Rosa brunonii*, *Pyrus pashia*, *Terminalia bellirica*, *T. chebula*, *Reinwardtia indica*, *Bauhinia vahlii*, *Dioscorea deltoidea*, *Butea monosperma*, *Asparagus racemosus* and *Rhododendron arboretum* (05 habitats, each); *Boeninghausenia albiflora*, *Berberis aristata*, *Elaeagnus parviflora*, *Azadirachta indica*, *Albizia julibrissin*, *Morus alba*, *Mucuna pruriens*, *Nepeta hindostana*, *Acacia catechu*, *Cedrus deodara*, *Plantago ovata*, *Zizyphus oxyphylla*, *Z. rugosa*, *Lannea coromandelica*, *Elephantopus scaber*, *Millettia auriculata*, *Dalbergia sissoo*, *Flacourtia indica* and *Salvia nubicola* (04 habitats, each), etc., showed wide range of distribution and habitat preferences but due to over exploitation for various purposes, and also due to habitat degradation, some of these species are facing high degree of threats. Promotion of mass scale propagation through conventional and in

in vitro methods of such species and their rehabilitation in the *in-situ* conditions or akin habitats may help in conservation and management.



Figure 2: Notable threatened plants of Murari Devi and surrounding areas in Mandi district of Himachal Pradesh, India.

Amongst habitats, 66 species were reported from the dry, 60 species in shady moist, 58 species degraded, 48 species in bouldary, 33 species in riverine, 20 species in shrubbery, 18 species in near crop field/cultivated field, 15 species in waste places/road side, 14 species in rocky and 07 species in Water courses/marshy places support maximum number of threatened species, hence merit conservation attention. These species and habitats represent the maximum part of the area, therefore, require adequate conservation measures. Altitudinal zone, 700-1300ms howed the richness of threatened species. This may be due to heavy biotic pressure on this zone leading to habitat degradation and ultimately to extinction of the species. To develop an appropriate strategy for the conservation and management of all these threatened species and their habitats, population assessment and habitat monitoring using standard ecological methods are urgently required.

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