Assessment of plant diversity for threat elements: A case study of Nargu wildlife sanctuary, north western Himalaya

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Abstract: Biodiversity crisis is being experienced throughout the world, due to various anthropogenic and natural factors. Therefore, it is essential to identify suitable conservation priorities in biodiversity rich areas. For this myriads of conservational approaches are being implemented in various ecosystems across the globe. The present study has been conducted because of the dearth of the location-specific studies in the Indian Himalayas for assessing the ‘threatened species’. The threat assessment of plant species in the Nargu Wildlife Sanctuary (NWS) of the northwest Himalaya was investigated using Conservation Priority Index (CPI) during the present study. CPI was calculated using cumulative values of various qualitative and quantitative attributes viz., habitat specificity, population size, distribution range, use values, extraction, nativity and endemism of the taxa. Out of a total of 733 species recorded in the area, 102 species (20 Trees; 14 Shrubs; and 68 Herbs) belonging to 82 genera and 54 families were identified as threatened. The study revealed that 8 species ‘Critically Endangered’, 17 species ‘Endangered’ and 77 species ‘Vulnerable’. These species must be monitored and actively managed with appropriate conservation strategies including periodical assessment of populations using standard ecological methods in order to conserve the high biodiversity in the NWS.

Keywords: Conservation, endemism, Himalaya, nativity, threatened.

INTRODUCTION

Biodiversity is one of the major livelihood options as it provides many ecosystem services including provisioning, regulating, supporting and cultural (MA, 2005). Several elements of biodiversity (e.g. species, habitats and ecosystem services) are in decline as the human domination of the earth continues to increase (Groombridge and Jenkins, 2000; Hilton-Taylor, 2000; GEO3, 2002). Major threats to ecosystems and biodiversity are habitat fragmentation and its losses, over exploitation, invasions of non-native species, global climate change (IUCN, 2003) and disruption of community structure (Novasek and Cleland, 2001). As a result of the anthropogenic pressure, the plant extinction rate has reached to 137 species per day (Mora et al., 2011; Tali et al., 2015). At present, the rapid loss of species is estimated to be between 1,000–10,000 times faster than the expected natural extinction rate (Hilton-Taylor, 2000). Under the current scenario, about 20% of all species are likely to go extinct within next 30 years and more than 50% by the end of 21st century (Myers, 1993). The most direct measure of the threats to the biodiversity can be derived from the assessments of conservation status of the species. The IUCN Red List of Threatened Species, categorize species that have a high probability of extinction in the future as ‘Critically Endangered’, ‘Endangered’ or ‘Vulnerable’. The degradation and fragmentation of >70% of the original habitats have placed Himalaya in the list of Global Biodiversity Hotspots, where only 25% of the original habitats are remaining unaffected due to various natural and anthropogenic pressures (Mittermeier et al., 2004). The Convention on Biological Diversity Summit (June, 1992) signaled the global recognition of the alarming loss of biodiversity. Since then, various studies have been conducted to explore and identify the threatened plants of the world (Singh, 2002). As far as the matter of assigning the threat status to a species is concerned, a species’ global conservation status, is not necessarily the same as the conservation status on a regional scale. However, it is often argued that status of a particular species may vary from region to region, thus local needs and threats should also be considered while deciding conservation priorities (Silva and Albuquerque, 2010). Some species that

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are threatened on the global scale may not be threatened at a regional scale, and species that are not threatened on a global scale might be threatened in some parts of their range (Gardenfors et al., 2001). Moreover, knowing the regional status of species is important as the loss of population and genetic diversity has become a major concern in the present scenario (Grammont and Cuaron, 2006). When a species is protected at the regional level, conservation of its genetic diversity is promoted (Hunter and Hutchinson, 1994). Regional scale extinction of one species can trigger a cascade of extinctions, causing a change in species structure, composition and in ecosystems processes (Lundberg et al., 2000). This deviation in the threat status from region to region clearly suggests that local situation must be taken into account while setting conservation priorities. Therefore, growing awareness on the importance and high rates of loss biodiversity make it imperative to rapidly assess and conserve biodiversity, both at regional and global levels. Since IUCN categorization only is not sufficient for formulating the local and regional conservation strategies as usually it has a larger area under its influence. Hence, there is need of collecting and maintaining precise and accurate information that can be used for the area specific prioritization of species. Many researchers have studied the threatened plants in Indian Himalayan Region (IHR) (Pangtey and Samant, 1997; Samant et al., 1998; Pandey and Well, 1997; Kala et al., 1998; Dar and Naqshi, 2001; Badola and Pal, 2003; Ved et al., 2003; Rana and Samant, 2010; Banerji and Basu, 2011; Goraya et al., 2013 and Tali et al., 2015). Various studies have been carried out in the protected and unprotected areas of Himachal Pradesh (Lal, 2007; Rana and Samant, 2010; Sharma, 2013).

Although, there has been an increasing recognition of the significance of the wider landscape and community conservation approaches, the central role of protected areas in conservation is still widely recognized (Monzón et al., 2011; Zomer et al., 2015). Only a few studies have been carried out in the protected areas using different attributes of rarity i.e., habitat preference, population size, nativity/endemism, anthropogenic pressure and distribution range (Rawal and Dhar, 1997; Samant, 1999; Joshi and Samant, 2004; Kala, 2004; Samant and Joshi, 2005; Lal, 2007; Rana and Samant, 2010, etc.). Although located on the northwestern slopes of Himalaya the threat assessment of all the species of Nargu Wildlife Sanctuary has not been carried out so far. Therefore, the present study attempts to assess the threat categories of species, study their distribution pattern and suggest conservation options considering the results.

MATERIALS AND METHODS

Study area

The study was conducted from 2010 to 2015 in Nargu Wildlife Sanctuary (NWS) (31°46′36″ to 32°04′00″ N Latitudes and 76°50′00″ to 77°04′30″ E Longitudes) which is located in Chuhar valley of Mandi district of Himachal Pradesh (Figure 1). The Sanctuary, which was declared in 1972, is surrounded by Kullu, Mandi, Jogindernagar and Palampur Forest Divisions. It covers an area of over 278.38 km² with an altitudinal range, 970 – 4,052 m asl.

The whole area is mainly mountainous with undulating low hills in the west and steep to precipitous mountains in the north and east. There are numerous high ridges, deep gorges and cliffs and narrow valleys. The climate of the area is sub-tropical, temperate, sub-alpine and alpine and consists of summer (mid April-mid June), rainy (mid June-September) and winter (October-March) seasons. The area receives precipitation both in the form of snowfall and rainfall. About 80% of the precipitation is received by southwest monsoon and the rest by western disturbances. However, the Sanctuary is now rationalized as per notification (No. FFE-B-F(6)-16/1999-Nargu; Dated, 29 November 2013) of the Government of Himachal Pradesh, Department of Forests. The study was conducted in the non-rationalized area as it was proposed earlier to this notification.
Sampling

Number of surveys were conducted between 970 – 4,052 m in NWS in all the seasons 2010 to 2015 to investigate the stated objectives. Random sampling was done for the qualitative analysis of vegetation in all the seasons (summer, rainy and winters) for the floristic surveys. However, for the quantitative assessment for threat categories, the sampling was conducted during July to September each year. A total of 136 sites were sampled in NWS where, 111 sites were in forests and 25 sites were in alpine zones. In the forest zone, a plot of 50 × 50 m was laid in each site. For shrubs, 20 quadrats of 5 × 5 m, and for herbs, 20 quadrats of 1 × 1 m were randomly
laid within the same plot. Shrubs were considered as the woody species having several branches arising from their bottom (Saxena and Singh, 1982). For assessing the alpine vegetation in each site, a 20 × 20 m plot was laid and within it 10 quadrats of 5 × 5 m for shrubs and 20 quadrats of 1 × 1 m for herbs were randomly laid. Standard ecological methods (Saxena and Singh, 1982; Singh and Singh, 1992; Dhar et al., 1997; Joshi and Samant, 2004; Samant and Joshi, 2005) were used for the collection and analysis of the data viz., population of the species etc. The Global Positioning System (Make; Garmin GPSmap 76CSx) is used for recording the geo-references, altitude and aspect etc. The record of the indigenous uses is mostly based on the interviews done with the people during the surveys, however in the case of medicinal plants information on indigenous uses were updated with the help of relevant secondary information (Jain, 1991; Samant and Palni, 2000; Samant et al., 2007). The interviews were conducted mostly on individual-basis, except in some cases, where several people participated at the same time. Interviews were done with the help of open and semi structured questionnaires.

The habitats in the sanctuary were identified based on the physical characters and dominance of vegetation. Moist and humus rich shady sites were considered as moist habitat while low percent of the same as dry habitat. The sites facing high anthropogenic pressure were considered as degraded habitats and sites having single large rock as rocky whereas others as used for camping by the shepherds or grazers as camping sites. The ones having >50% boulders of the ground cover were considered as bouldary and others nearby the water streams as riverine. The sites having submerged vegetation or having excess moisture are considered as marshy, alpines pastures as dry or grasslands as per the moisture content in the soil and others having >50% of shrubs were considered as shrublands.

Data analysis

Vegetation data

The nativity of a species denotes its origin or first record (Samant et al., 1998) and has been identified (Anonymous, 1883-1970; Samant and Dhar, 1997; Samant et al., 1998, 2000; http://www.ipni.org). In case of Pteridophytes, the species distributed in the Himalayan Region have been considered as native to the region whereas the remaining species as non-natives. Endemism of the species has been identified based on distribution of the species (Dhar and Samant, 1993; Samant et al., 1998, 2000; Samant and Dhar, 1997; Samant, 1999). The species restricted to the Himalayan region have been considered as endemic.

For knowing the regional threat status of a particular species, Conservation Priority Index (CPI) was calculated to categorize species under different threat categories in the NWS (Rana and Samant, 2010). The cumulative values of the various attributes viz., habitat specificity, population size, distribution range, use values, extraction, nativity and endemism of the taxa were used to calculate the CPI for each species. To calculate CPI, the number of parameters used for each species was given grade/marks, maximum 10 point; moderate 6 points and minimum 2 points (Table 1). Therefore, the lowest grade minimum score i.e., 2 was assigned instead of zero. The species fulfilling all the attributes in the highest grade resulted in highest cumulative values and one which falls in the lowest for each attribute resulted in lowest cumulative values. The highest marks possible was 60, meaning all the characteristics were present and satisfactory for that particular taxa. The species having >60% of the total CPI were considered as ‘Critically Endangered’; 55-59% as ‘Endangered’; 50-54% as ‘Vulnerable’; and 45-49% as Near Threatened, whereas <45% were considered as Least Concern (Rana and Samant, 2010).

The regionally threatened species of the NWS were compared to the threatened species of State and globe following (Nayar and Sastry, 1987-90; Ved et al., 2003; Rana and Samant, 2010; Goraya et al., 2013). The species, that was observed outside the sampled sites were also considered for categorization.

RESULTS

Threat Categorization and Species Diversity

The present study recorded 733 species of vascular plants i.e., angiosperms (113 families, 366 genera and 680 species), gymnosperms (3 families, 6 genera and 9 species) and pteridophytes (16 families, 25 genera and 44 species). Of the total species, 74 species were trees, 125 shrubs, 490 herbs and 44 pteridophytes. Among these, 102 species (20 Trees; 14 Shrubs; and 68 Herbs) belong to 82
genera and 54 families have been identified as ‘threatened’ from the NWS (Table 2). Out of the total, 66 species were cited in the sampled sites.

In the present study, 8 species were categorized as Critically Endangered, 17 species as Endangered; 77 species as Vulnerable, 158 species as Near Threatened and other 473 species as least concerned (Table 2). Species have been categorized as Critically Endangered (3 spp.); Endangered (13 spp.) and Vulnerable (29 spp.) for Himachal Pradesh using IUCN criteria. Critically Endangered (1 spp.), Endangered (4 spp.) and Vulnerable (4 spp.) were identified according to the global threat categories.

Altitudinal distribution

In general maximum number of species (i.e., 546 spp.) was recorded in the altitudinal zone, 1801-2800 m. The diversity decreased with the increasing altitude. Similarly, along an altitudinal gradient, the maximum threatened species (68 spp.) were distributed in 1801-2800m zone, followed by 2801-3800 m (56 spp.) zone (Figure 2).

Site Wise Distribution

Among the 136 sites at NWS, a total of 589 species (Trees: 54; Shrubs: 85 and Herbs: 450) have been recorded. 514 species (Trees: 55; Shrubs: 83 and Herbs: 376) were reported from the forest zone and 282 species (Shrubs: 14; Herbs: 268) from the alpine zone. Eighty two (82) species were present in a single site, sixty four species (64) in two sites, fifty four species (54) in three sites, fifty eight species (58) in four sites, fifty two species (52) in five sites, twenty six species (26) in six sites and twenty three species (23) in seven sites. The rest of the 230 species were reported in more than seven sites.

Table 1: Attributes used for Threat Categorization of Species in NWS.

| Grade/ marks | Altitudinal Range (m) | H | Use Values | Population Size/locations | Native & Endemic | Extraction |
|--------------|-----------------------|---|------------|---------------------------|------------------|------------|
| 10           | <500                  | 1 | > 4        | <50 Ind or 2 locations    | Native & Endemic | Commercial |
| 6            | 500-1000              | 2-3| 3-4        | 50-250 or 3-5 locations   | Native/Endemic   | Self-Use   |
| 2            | >1000                 | >3 | <3         | >250 Ind or >5 locations  | Non-native       | No Extraction |

Abbreviations Used: H= No. of Habitat(s); Ind= No. of individuals

Figure 2: Altitudinal distribution of threatened plant species in NWS.
Distribution of plant species among different Habitat

Of the total species recorded, 14 were habitat specific, 176 were recorded in two habitats, 308 in three habitats and 235 in more than three habitat types. Of the threatened species reported, habitat wise distribution of the species in the forest and alpine zones of the sanctuary had 7 species only distributed in one habitat, 28 species in two habitats whereas 67 species were distributed in 3 or >3 habitats. Among the species, *Melothria heterophylla* (6 habitats), *Salvia lanata*, *Ribes alpestre*, *Lagotis cashmeriana*, *Juglans regia* and *Dioscorea deltoidea* (5 habitats, each), *Vincetoxicum hirudinaria*, *Viburnum mullaha*, *Trichosanthes tricuspidata*, *Thamnocalamus spathiflora*, *Swertia ciliata*, *Swertia angustifolia*, *Rhodiola heterodonta*, *Phegopteris connectilis*, *Olea ferruginea* and *Cinnamomum tamala* (4 habitats, each) were distributed among maximum number of habitats (Table 2).

Nativity and endemism

From the total recorded species, 414 species were native to the Himalayan Region, while the remaining species were exotics. Twelve species were endemic and 152 species near endemic to the IHR. Whereas among the threatened and near threatened species 184 species were native, 76 exotics, 10 endemic and 73 near endemic to the Indian Himalayas. However, of the quantified species about 68.3% were native to the Himalaya. About 20.3% of the total and 29.8% of the native species were near endemic and 1.9% of the total and 2.7% of the natives were endemic to the IHR.

Extraction of species

A total of 552 species were identified as economically important plants (belonging to 120 families and 332 genera). These species were used as medicine (371 spp.), wild edible/food (131 spp.), fodder (206 spp.), fuel (87 spp.), fiber (12 spp.), religious (28 spp.), timber (14 spp.), making agricultural tools (16 spp.) and for miscellaneous domestic and commercial purposes.

Among threatened and near threatened species, 32 species were extracted for commercial purposes while 129 species extracted by inhabitants for their own use. For example, *Aconitum heterophyllum*, *Aesculus indica*, *Allium humile*, *Angelica glauca*, *Arnebia benthamii*, *Cedrus deodara*, *Dactylorhiza hatagirea*, *Dioscorea deltoidea*, *Habenaria edgeworthii*, *Juniperus indica*, *Jurinea macrocephala*, *Malaxis muscifera*, *Picea smithiana*, *Picrorhiza kurrooa*, *Podophyllum hexandrum*, *Rheum australe*, *Rhododendron arboreum*, *Taxus baccata* subsp. *wallichiana*, *Toona ciliata*, *Valeriana jatamansi* etc. are valued for various commercial purposes.

Population size and site representation

Among the quantified plants 32% species (190 spp.) had only < 50 individuals in the sampled sites, 37% (218 spp.) with population size of 51-250 individuals and 31% (181 spp.) with population size >250 individuals. One hundred forty four species were not represented in any sampled sites and they were considered as species with low population size.

Among the threatened species, 28 species had only <50 individuals in the sampled sites and 28 species with population size of 51-250 individuals and seven species had population size of >250 individuals.

DISCUSSION

Ecologists observe that the massive extinction of the species is occurring in high altitudinal areas like the Himalaya that have high biological diversity including many endemic species. At present, biodiversity crisis is being experienced throughout the world, therefore suitable conservation actions need to be set up for optimal use of limited resources. Studies indicate that we have altered approximately half of the habitable surface of the earth (Daily, 1995; Singh, 2002). Therefore, myriads of conservational approaches are being implemented in various ecosystems across the globe. Unfortunately, none of the available methods of setting conservation priorities are generally accepted, as their data requirements are too strict, scientifically unsound, or are too complex for the usage by decision makers (Schmeller et al., 2008). Majority of the studies of setting the priorities for conservation of the plant species have been carried out using qualitative observations only. The IUCN status of the species is based on the published flora, reports and research papers which are typically based on qualitative observations. In addition, threat assessments were based on opinion and perception of specialists during workshops and
meetings (Ved et al., 2003, 2005; Goraya et al., 2013). Though, such exercises help in prioritizing species for conservation and management, they do not provide the authentic information on the actual status of the species, which is only possible through ground validation. Therefore, location specific studies are essential to set conservation priorities. For this purpose, assessment of the status of species using qualitative and quantitative attributes has only been suggested by few workers (Samant et al., 1996; Airi et al., 1997). Likewise, Rawal and Dhar (1997) have attempted to estimate the sensitivity of the timberline flora of Kumaun Himalaya based on habitat specificity, distribution range and population size, but others highlight the necessity of further thorough investigation (Rana and Samant, 2010).

The plant species are facing natural and anthropogenic threats at the NWS. The habitats of most of these threatened species fall within the extensively grazed alpine meadows and sub-alpine zones. Animals which browse leaves and reproductive parts of plant species damage their flowering spikes and thereby restrict their population size and distribution (Ganie and Tali, 2013). Most of the individuals of different species were not able to produce seeds because the flowers are extensively grazed by livestock threatening their long-term survival.

The population size, habitat specificity, nativity and endemism, distribution range and use pattern play a significant role in decision making of the status of a species in particular area. In the present study, threat assessment of floristic diversity for the NWS has been carried out for the first time. On the basis of cumulative values (i.e., CPI) of conservation attributes, species have been categorized. The higher CPI indicates the need for a greater level of attention to local strategies for conservation and management. Categorization of 8 species as Critically Endangered, 17 species as Endangered; 77 species as Vulnerable and 158 species as Near Threatened indicated the high degree of anthropogenic pressure in the area. Existence of species such as Allium humile, Dactylorhiza hatagirea, Fritillaria roylei, Jurinella macrocephala, Aconitum heterophyllum, Angelica glauca, Dioscorea deltoidea, Malaxis muscifera, Picrorhiza kurrooa and Paris polyphylla were highly threatened in the NWS as well as globally hence they have high conservation importance. Altering the land use, climate change, nitrogen deposition, biological exchange and atmospheric carbon dioxide are the major factors contributing towards change in biodiversity. Moreover, climate change is not been considered as a major threat for plants and therefore it is less important than the change in land use types (Sala et al., 2000).

Pressure of human overpopulation and climate change interfere with the natural ecosystems and introduction of non-native species increase pressure on survival of the native species (Vitousek, 1990; Levine et al., 2003; Serrill, 2006). Anthropogenic activities such as extraction of resources by humans, tourism and livestock grazing spread non-native species into the forested areas. Disturbance leads to the invasion of non-native species (Huston, 1994). Hence, there seems is a strong need for increased surveillance, early detection, and eradication of non-native and invasive species from the area as these out-compete the natives and destabilize the local ecosystem.

Altitudinal zone, 1801-2800m had the highest 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. Besides, occurrence of 9 species in only one site and 8 species in two sites indicated the early extinction of these species if the habitat degradation and anthropogenic activities continue to operate. Similarly, occurrence of 7 species only in one habitat and 28 species in two habitats indicated their high habitat preferences. Such species have less chances of proliferation than the species with wide range of habitats (Samant et al., 1996).

Species such as Valeriana jatamansi (35 sites, 3 habitats), Bergenia ciliata (29 sites, 2 habitats), Thamnocalamus spathiflora (21 sites, 4 habitats), Hedychium spicatum (20 sites, 3 habitats), Viburnum mullaha (19 sites, 4 habitats), Parnassia nubicola (12 sites, 4 habitats), and Symlocos chinensis (12 sites, 2 habitats), Swertia angularis (11 sites, 4 habitats) and Skimmia laeureola (11 sites, 3 habitats), etc., had wide range of distribution and habitat preferences, due to over-exploitation for various purposes and habitat degradation, these species too facing high degree of threat. Amongst habitats, shady moist, rocky and dry forest habitats supports maximum number of
threatened species, hence these require priority for conservation.

However, the distribution of the preferred economically valuable species in the sanctuary indicated their availability in the area, but continuous exploitation of these species may lead to their population depletion. Low density of the preferred species indicated high anthropogenic pressure, which may lead to the extinction of these species in near future and replaced by the other less economically important species. This may too affect the regional ecology because imperative use of plant resources is a direct threat to biodiversity and the continued proper functioning of mountain ecosystems (Sharma et al., 2010; Tarra’s et al., 2010).

Nevertheless, the protected area systems are not entirely safe, thus the threatened species have no guarantee to remain safe (Krupnick, 2013). To maintain the viability of a threatened plant population in a protected area, the species must not suffer from the ‘benign neglect’ approach to conservation (Heywood and Iriondo, 2003). Species within protected areas must be monitored and actively managed. For long-term resilience of landscapes of the NWS that remain under cultivation or grazing, it is more important to create corridors of forest cover to encourage the dispersal agents that use them and prohibit any anthropogenic activity in the area. In addition to the above, an appropriate conservation strategy by periodical assessment of population and habitats’ monitoring of the threatened species using standard ecological methods are suggested.

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Table 2: Status of the threatened plants in NWS.

| Taxa                                      | Family          | Nativity       | LF   | AR (m)  | Habitats | Status   |
|-------------------------------------------|-----------------|----------------|------|---------|----------|----------|
| **Critically Endangered (CR)**            |                 |                |      |         |          |          |
| *Aconitum heterophyllum* Wall.ex Royle*   | Ranunculaceae   | Reg Himal      | H    | 3000-4100 | 1,7,8    | CR       |
| *Allium humble* Kunth*                    | Alliaceae       | Reg Himal Ind Or | H    | 3200-4000 | 1,7      | -        |
| *Allium wallichii* Kunth                  | Alliaceae       | Reg Himal      | H    | 2500-4100 | 1,7      | -        |
| *Dactylorhiza hatagirea* D. Don           | Orchidaceae     | Reg Himal Eur Afr Bor Or | H | 2800-3870 | 1,7  | CR  |
| *Habenaria edgeworthii* Hook.f. ex Collert* | Orchidaceae    | Reg Himal     | H    | 1500-3000 | 1    | -        |
| *Malaxis muscifera* (Lindl.) Kuntze       | Orchidaceae     | Europ          | H    | 1800-3200 | 1,7 | CR | - |
| *Picrorhiza kurrooa* Royle                | Scrophulariaceae| Reg Himal     | H    | 2800-3850 | 1,2,8 | EN    |
| *Podophyllum hexandrum* Royle             | Podophyllaceae  | Ind Or As Trop | H    | 2500-3700 | 1,7 | EN | - |
| **Endangered (EN)**                       |                 |                |      |         |          |          |
| *Acer caesium* Wall. ex Brandis*          | Aceraceae       | Reg Himal      | T    | 2100-3200 | 1,2,9  | -        |
| *Aconitum violaceum* Jacq. ex Stapf.*     | Ranunculaceae   | Reg Himal      | H    | 3500-4000 | 1,7,8 | VU       |
| *Aconitum laeve* Royle                    | Ranunculaceae   | Reg Himal      | H    | 2700-3000 | 1,7 | -        |
| *Allium stracheyi* Baker*                 | Alliaceae       | Reg Himal      | H    | 3600-3800 | 1 | VU | VU |
| *Angelica glauca* Edgew. *                | Apiaceae        | Reg Himal      | H    | 2000-2800 | 1,7 | EN | EN |
| *Berberis asiatica* Roxb. ex DC.          | Berberidaceae   | Reg Himal      | Sh   | 1200-2000 | 1,2 | -        |
| *Betula utilis* D. Don                    | Betulaceae      | Reg Himal Japon | T  | 2700-3400 | 8,9 | EN | - |
| *Cinnamomum tamala* (Buch.-Ham.) Nees & Ebermaeir | Lauraceae      | Reg Himal      | T    | 1000-1500 | 1,2,3 | VU | - |
| *Euonymus tingens* Wall.                  | Celastraceae    | Reg Himal      | T    | 1700-2900 | 1,2,10 | - | - |
| *Fritillaria roylei* Hk.                  | Liliaceae       | Reg Himal      | H    | 2700-3500 | 1 | EN | EN |
| *Hypericum perforatum* L.                 | Hypericaceae    | Europ          | H    | 1100-2200 | 1,2,3,4 | VU | - |
| *Jurinella macrocephala* (Benth. ex Hk. f.) Aswal & Malhotra | Asteraceae | Reg Himal | H | 3000-3850 | 1,7 | EN | - |
| Taxa                                    | Family         | Nativity    | LF  | AR (m) | Habitats | Status |
|-----------------------------------------|----------------|-------------|-----|--------|----------|--------|
| Nervilia plicata L.                     | Orchidaceae    | Reg Himal   | H   | 1050-1200 | 5        | -      |
| Paris polyphylla Sm.                    | Liliaceae      | Reg Himal China | H | 1200-2200 | 1,2,3,  | EN     |
| Rhodiola heterodonta (Hk. & Th.) A. Boriss.* | Crassulaceae  | Reg Himal   | H   | 2930-4000 | 1,2,3,8  | VU     |
| Taxus baccata ssp. wallichiana (Zucc.) Pilger | Taxaceae     | Reg Himal   | T   | 2500-3300 | 1,2      | EN     |
| Trillium govanianum Wall. ex D.Don      | Trilliaceae    | Reg Himal   | H   | 2300-3300 | 1,10     | -      |

**Vulnerable (VU)**

| Taxa                                    | Family         | Nativity    | LF  | AR (m) | Habitats | Status |
|-----------------------------------------|----------------|-------------|-----|--------|----------|--------|
| Acer cappadocicum Gled.                 | Aceraceae      | Asia Minor  | T   | 2600-3000 | 1,3      | -      |
| Acer oblongum Wall.                     | Aceraceae      | Reg Himal   | T   | 1400-1950 | 1,9      | -      |
| Acorus calamus L.                       | Araceae        | Reg Bor Temp | H  | 1300-2200 | 5,11     | -      |
| Aerva sanguinolenta (L.) Bl.            | Amaranthaceae  | Java        | H   | 1000-1200 | 1,2      | -      |
| Aralia cachemirica Decne.*             | Araliaceae     | Reg Himal   | H   | 2500-3050 | 2,3      | -      |
| Asparagus racemosus Wild.               | Asparagaceae   | Ind Or Afr Trop Austr | H  | 1300-1700 | 1,2,4    | -      |
| Berberis aristata DC.*                 | Berberidaceae  | Ind Or      | Sh  | 1200-2800 | 10       | -      |
| Bergenia ciliata (Hew.) Stercb.*       | Saxifragaceae  | Reg Himal   | H   | 2000-3500 | 2,3      | -      |
| Betula alnoides Buch.-Ham. ex D.Don     | Betulaceae     | Reg Himal Japon | T | 1800-2500 | 1,2,4    | -      |
| Boschniakia himalaica Hk.f. & Th. ex Hk.f. | Orobanchaceae | Reg Himal   | H   | 2700-3300 | 1        | -      |
| Bupleurum atrovioleaceum (Schulz) Nasir* | Apiaceae      | Pak Himal   | H   | 2100-3000 | 1,7,8    | -      |
| Campanula latifolia L.                  | Campanulaceae  | Europ Or As Temp | H  | 2600-3500 | 2,3,8    | -      |
| Clintonia udensis Trautv. & Mey.        | Liliaceae      | Siberia Japon | H  | 3200-4000 | 1,7,10   | -      |
| Corydalis govaniana Wall.               | Fumariaceae    | Reg Himal   | H   | 3000-4000 | 1,2,7    | -      |
| Corylus jacquemontii L.*                | Corylaceae     | Europe Or As Min Himal | T  | 2490-2900 | 1,5      | -      |
| Deeringia amaranthoides (Lam.) Merr.    | Amaranthaceae  | As et Afr Trop | Sh | 1000-1400 | 1,2      | -      |
| Delphinium denudatum Wall. ex Hk. f. & Th.* | Ranunculaceae | Reg Himal   | H   | 2000-2600 | 1,2,5    | -      |
| Desmodium gangeticum (L.) DC.           | Fabaceae       | As Trop Austr | Sh | 1000-1500 | 1,2,3    | -      |
| Taxa                                      | Family            | Nativity     | LF | AR (m) | Habitats | Status |
|-------------------------------------------|-------------------|--------------|----|--------|----------|--------|
| Dioscorea deltoidea Wall.                 | Dioscoreaceae     | Ind Or       | H  | 950-2500 | 1.2,3    | EN     |
| Drepanostachyum falcatum (Nees) Keng f.   | Poaceae           | Reg Himal    | Sh | 1700-2200| 1.2      | -      |
| Engelhardtia spicata Leschen. ex Bl.      | Juglandiaceae     | Reg Himal Malaya | T  | 1000-1600 | 1.2,3    | -      |
| Gymnopteris vestita (Wall. ex Moore) Underwood | Hemionitidaceae | -            | Fn | 1000-2500 | 1.2,3    | -      |
| Hedychium spicatum Sm.*                   | Zingiberaceae     | Reg Himal    | H  | 1000-2500 | 1.2,5    | -      |
| Heracleum candicans Wall. ex DC.          | Apiaceae          | Reg Himal    | H  | 1500-2800 | 1.2,4    | -      |
| Heracleum wallichii DC*                   | Apiaceae          | Reg Himal    | H  | 3500-4000 | 1.9      | -      |
| Herminium monorchis (L.) R.Br.            | Orchidaceae       | Europ As Bor | H  | 2000-4000 | 1.5,7    | -      |
| Himalayacalamus falconeri Keng f.         | Poaceae           | Reg Himal    | H  | 2000-3000 | 1.2,4    | -      |
| Juglans regia L.*                        | Juglandiaceae     | Reg Himal As Occ | T  | 1700-3000 | 1.2,3,9  | -      |
| Lagotis cashmeriana Rupr.*                | Scrophulariaceae  | Reg Himal    | H  | 3100-4100 | 1.3,6,7,8| -      |
| Lannea coromandelica (Houtt.) Merr.       | Anacardiaceae     | Ind Or       | T  | 980-1300  | 2.4,5    | -      |
| Leycesteria formosa Wall.                 | Caprifoliaceae    | Reg Himal    | H  | 1500-2800 | 1.2,4    | -      |
| Malaxis acuminata D. Don                  | Orchidaceae       | Reg Himal    | H  | 1600-2500 | 1       | -      |
| Melolithia heterophylla (Lour.) Cogn.     | Cucurbitaceae     | As Trop et Sub Trop | H  | 2000-2500 | 1.2,4,5  | -      |
| Morus serrata Roxb.                       | Moraceae          | Reg Himal    | T  | 970-2300  | 2.3      | -      |
| Nepeta govaniana Benth.*                  | Lamiaceae         | Reg Himal    | H  | 1700-2800 | 1.2,7    | -      |
| Olea ferruginea Royle*                    | Oleaceae          | Reg Himal    | T  | 1300-1600 | 2.9      | -      |
| Osmunda japonica Thunb.                   | Osmundaceae       | -            | Fn | 2100-2500 | 1.9      | -      |
| Parnassia nubicola Wall. ex Royle*        | Parnassiaceae     | Reg Himal    | H  | 3000-4000 | 1.7,8    | -      |
| Parnassia pusilla Wall. ex Arn.           | Parnassiaceae     | Reg Himal    | H  | 2300-3600 | 1.7      | -      |
| Pellaea nitidula (Wall. ex Hk.) Hk. et Baker | Sinopteridaceae | -            | Fn | 2000-2300 | 1, 2, 6  | -      |
| Phegopteris connectilis Watt.             | Thelypteridaceae  | -            | Fn | 2600-3050 | 1.3,5,7  | -      |
| Phoenix humilis (L.) Cav.                 | Arecaceae         | Ind Or       | T  | 1000-1500 | 5        | -      |
| Phymatopteris stracheyi (Ching) Pic. Serm. | Polypodiaceae    | -            | Fn | 2500-3300 | 1.2,4    | -      |
| Pistacia integerrima (Stewart) Rech. f.   | Anacardiaceae     | Egypt Persia Reg | T  | 1000-2200 | 1.2      | -      |
| Taxa                                           | Family          | Nativity        | LF      | AR (m)  | Habitats | Status |
|-----------------------------------------------|-----------------|-----------------|---------|---------|----------|--------|
| **Pleurospermum anglicoides** (DC.) Cl.       | Apiaceae        | Reg Himal       | H       | 3000-3650 | 1,2,7    | -      |
| **Pleurospermum brunonis** Cl.*               | Apiaceae        | Reg Himal       | H       | 3000-3650 | 1,7      | -      |
| **Pleurospermum candollii** (DC.) Cl.*        | Apiaceae        | Reg Himal       | H       | 3000-3850 | 1,7,8    | -      |
| **Polygonatum multiflorum** (L.) All.         | Liliaceae       | Europ As Bor    | H       | 3000-4000 | 1,2      | VU     |
| **Polygonatum verticillatum** (L.) All.       | Liliaceae       | Europ As Bor    | H       | 1700-3500 | 1,2,3    | VU     |
| **Rheum austral** D.Don*                      | Polygonaceae    | Reg Himal       | H       | 2500-3300 | 1,7,8    | -      |
| **Rheum moorcroftianum** Royle*               | Polygonaceae    | Reg Himal       | H       | 3500-4100 | 1,7,8    | EN     |
| **Rheum lepidotum** Wall.                     | Ericaceae       | Reg Himal       | Sh      | 2700-3100 | 7,8,10   | VU     |
| **Rhus cotinus** L.                           | Anacardiaceae   | Mediter Or Reg Himal China | Sh | 1100-1800 | 1,2,3 | - |
| **Rhus wallichii** Hk.f.*                     | Anacardiaceae   | Reg Himal       | T       | 1500-2400 | 1,2,4 | - |
| **Ribes alpestre** Wall. ex Decne.            | Grossulariaceae | China Xizang    | Sh      | 2000-3300 | 1,2,5,10 | - |
| **Roylea cinerea** Wall. Ex Benth.*           | Lamiaceae       | Reg Himal       | Sh      | 1200-3700 | 1,3,7,9 | VU, VU |
| **Salvia lanata** Roxb.*                      | Lamiaceae       | Reg Himal       | H       | 1400-2500 | 1,2,3,10 | - |
| **Sambucus adnata** Wall.                     | Caprifoliaceae  | Reg Himal       | H       | 2500-2710 | 1,3     | - |
| **Saussurea taraxacifolia** Wall. ex DC.      | Asteraceae      | Reg Himal       | H       | 3100-3600 | 1,7,8    | -      |
| **Skimmia laureola** Sieb. & Zacc. ex Walp.  | Rutaceae        | Reg Himal       | Sh      | 1200-2800 | 1,2,10   | -      |
| **Sorbus lanata** (D.Don) Schauer             | Rosaceae        | Reg Himal       | T       | 2100-3000 | 1,2     | - |
| **Swertia cordata** Wall.*                    | Gentianaceae    | Reg Himal       | H       | 2700-3500 | 1,2,7    | -      |
| **Swertia angustifolia** Ham. ex D. Don       | Gentianaceae    | Reg Himal       | H       | 1500-3000 | 1,6,7,8  | -      |
| **Swertia ciliata** (G.Don) Burtt*            | Gentianaceae    | Reg Himal       | H       | 2700-4000 | 1,2,7,8  | -      |
| **Symplocos chinensis** (Lour.) Decne.        | Symplocaceae    | Japon           | T       | 1200-2600 | 1,2     | - |
| **Tanacetum dolichophyllum** Kitamura         | Asteraceae      | Mexico          | H       | 3000-4000 | 1,7     | - |
| **Thamnochalamus spathiflora** (Trin.) Munro* | Poaceae         | Reg Himal       | Sh      | 1000-3000 | 1,2,3,4  | - |
| **Toona ciliata** M. Roem.                    | Meliaceae       | Malaya Austr    | T       | 1000-1500 | 1       | - |
| **Trichosanthes tricuspidata** Lour.          | Cucurbitaceae   | China           | H       | 1300-2000 | 1,2     | - |
| Taxa                          | Family          | Nativity               | LF | AR (m) | Habitats       | Status |
|-------------------------------|-----------------|-----------------------|----|--------|----------------|--------|
| *Valeriana hardwickii* Wall. | Valerianaceae   | Reg Himal Malaya      | H  | 2000-3050 | 1,7,8          | -      |
| *Valeriana jatamansi* Jones  | Valerianaceae   | Reg Himal             | H  | 1400-3000 | 1,7,8          | VU     |
| *Vanda cristata* Lindl.       | Orchidaceae     | Reg Himal As Trop     | H  | 1300-2100 | 1              | -      |
| *Viburnum grandiflorum* Wall. ex DC.* | Caprifoliaceae | Reg Himal             | Sh | 2500-3000 | 1,2,10         | -      |
| *Viburnum nudum* Buch.-Ham. ex D. Don | Caprifoliaceae | Reg Himal             | Sh | 1800-2500 | 1,2,3,10       | -      |
| *Vincetoxicum hirundinaria* Medik. | Asclepiadaceae | Europ Reg Cauc        | H  | 1500-2800 | 1,2,7          | -      |
| *Zanthoxylum armatum* DC.     | Rutaceae        | Reg Himal China       | Sh | 1000-2500 | 2,4,10         | EN     |
| *Zingiber chrysanthum* Ros.   | Zingiberaceae   | Reg Himal             | H  | 1200-1700 | 1,5            | -      |
| **Near Threatened**          |                 |                       |    |         |                |        |
| *Acer acuminatum* Wall. ex D.Don* | Aceraceae      | Reg Himal             | T  | 2900-3100 | 1,9            | -      |
| *Aechmanthera gossypina* Nees | Acanthaceae     | Ind Or                | Sh | 1000-2200 | 1,4            | -      |
| *Aesculus indica* Coleb. ex Wall.* | Hippocastanaceae | Reg Himal             | T  | 1500-2800 | 1,2,3,4        | -      |
| *Agave angustifolia* Haw.     | Agavaceae       | Mexico                | H  | 1300-1600 | 2,4            | -      |
| *Ajuga bracteosa* Wall. ex Benth. | Lamiaceae      | Afr Trop Ind Or As    | H  | 1000-2500 | 1,2,3,4        | -      |
| *Alangium chinense* (Lour.) Harms. | Cornaceae      | Ind Or China Japon    | T  | 1500-2200 | 1,2,5          | -      |
| *Albizia odoratissima* (L.f.) Benth. | Mimosaceae     | As Afr Trop           | T  | 1000-1500 | 2              | -      |
| *Anemone vitifolia* Buch-Ham. | Ranunculaceae   | Reg Himal             | H  | 1600-2800 | 1,4,8          | -      |
| *Aquilegia pubiflora* Wall. ex Royle* | Ranunculaceae | Ind Or                | H  | 1600-2600 | 1,5            | -      |
| *Arenaria pulvinata* Edgew.   | Caryophyllaceae | Reg Himal             | H  | 3300-3600 | 2,8,9          | -      |
| *Artemisia roxburghiana* Bess.* | Asteraceae     | Reg Himal             | H  | 1000-2700 | 1,2,4,5        | -      |
| *Asclepias curassavica* L.    | Asclepiadaceae  | Am Austr              | Sh | 980-1200 | 1              | -      |
| *Asplenium trichomanes* Cl.   | Aspleniaceae    | Japon China           | Fn | 1000-3000 | 1,9            | -      |
| *Astragalus chlorostachys* Lindl* | Fabaceae      | Reg Himal             | Sh | 1500-2500 | 1,3            | -      |
| *Astragalus himalayanus* Klotz.* | Fabaceae      | Reg Himal             | H  | 3000-4000 | 7,8            | -      |
| *Bauhinia varillii* Wight & Arn. | Caesalpiniaceae | Ind Or                | Sh | 970-1300 | 2,3,4          | -      |
| *Bauhinia variegata* L.       | Caesalpiniaceae | Ind Or Burma China    | T  | 950-1400 | 1,2,10         | -      |
| *Berberis lycium* Royle*      | Berberidaceae   | Reg Himal             | Sh | 1000-2700 | 1,2,4,8        | -      |
| Taxa                                           | Family           | Nativity       | LF  | AR (m) | Habitats | Status |
|------------------------------------------------|------------------|----------------|-----|--------|----------|--------|
| *Bergenia stracheyi* (Hk. f. & Th.) Engl.*    | Saxifragaceae    | Reg Himal      | H   | 2700-3650 | 3.9      | VU     |
| *Boenninghausenia albiflora* (Hk.f.) Reichenh.ex Meissn. | Rutaceae         | Reg Himal Japon | H   | 1200-2800 | 1.2      | -      |
| *Buddleja crispa* Benth.                      | Loganiaceae      | Reg Himal Japon | H   | 1700-2800 | 1.2, 5, 9 | -      |
| *Bupleurum candolii* Wall.ex DC.*            | Apiaceae         | Reg Himal Burma | Sh  | 2700-3500 | 1.7, 8   | -      |
| *Bupleurum hamiltonii* Balakr.               | Apiaceae         | Reg Himal      | H   | 1900-2500 | 1.3      | -      |
| *Calanthe tricarinata* Lindl.                | Orchidaceae      | Reg Himal      | H   | 2000-3300 | 1.2      | -      |
| *Caltha palustris* L.*                       | Ranunculaceae    | Ind Or         | H   | 2000-2600 | 1.11     | -      |
| *Carissa opaca* Stapf. ex Haines             | Apocynaceae      | Reg Himal      | Sh  | 1000-1500 | 1.2, 4   | -      |
| *Carpinus viminea* Lindl.                    | Corylaceae       | Reg Himal      | T   | 1500-2200 | 1.2, 4, 5 | -      |
| *Centipeda minima* (L.) A.Br. & Asch.        | Asteraceae       | As et Austr Trop Ins Pacif | H  | 1300-1700 | 1.2, 4, 9 | -      |
| *Cerastium fontanum* Baumg. subsp. membranaceum* (Edgew. & Hook.f.) | Caryophyllaceae  | Europ          | H   | 2500-4000 | 2.4, 9   | -      |
| *Ceropegia wallichii* Wight                  | Asclepiadaceae   | Reg Himal      | H   | 2500-2900 | 1.2      | -      |
| *Chaerophyllum acuminatum* Lindl.            | Apiaceae         | Reg Himal      | H   | 1800-3100 | 1.2      | -      |
| *Chaerophyllum reflexum* Lindl.              | Apiaceae         | Reg Himal      | H   | 2200-3000 | 1.2, 4   | -      |
| *Chaerophyllum villosum* Wall. ex DC.*       | Apiaceae         | Reg Himal      | H   | 2000-3000 | 1.2, 4   | -      |
| *Cheilanthes acrostica* Tod.                 | Sinopteridaceae  | -              | Fn  | 1000-2200 | 1.5      | -      |
| *Cissus repanda* Vahl                        | Vitaceae         | Ind Or         | Sh  | 1400-1600 | 1.2      | -      |
| *Clematis barbellata* Edgew.*                | Ranunculaceae    | Reg Himal      | Sh  | 990-2800  | 2.4      | -      |
| *Clematis buchananiana* DC.                  | Ranunculaceae    | Reg Himal      | Sh  | 1500-3300 | 2.4      | -      |
| *Clematis graveolens* Lindl.                 | Ranunculaceae    | Reg Himal      | Sh  | 2000-3000 | 2.3, 4, 10 | -    |
| *Clematis montana* Buch.-Ham. ex DC.         | Ranunculaceae    | Reg Himal      | Sh  | 1000-2300 | 3.10     | -      |
| *Colocasia affinis* Schott                   | Araceae          | Reg Himal      | H   | 1200-1700 | 1.2      | -      |
| *Coniogramme affinis* (Wall.) Hieron         | Hemionitidaceae  | -              | Fn  | 2000-3000 | 1.7, 8   | -      |
| *Coniogramme falcata* Salomon                | Hemionitidaceae  | -              | Fn  | 2000-2800 | 1.8      | -      |
| Taxa                                             | Family                | Nativity         | LF | AR (m) | Habitats | Status |
|-------------------------------------------------|-----------------------|------------------|----|--------|----------|--------|
| Coniogramme intermedia Hieron.                  | Hemionitidaceae       | -                | Fn | 1.7    | -        | -      |
| Coriaria nepalensis Wall.                       | Coriariaceae          | Reg Himal China  | Sh | 1700-2400 | 2,4,10   | -      |
| Cornus capitata Wall.                           | Cornaceae             | Reg Himal        | T  | 1200-2300 | 1,2,4    | -      |
| Corydalis cashmeriana Royle*                    | Fumariaceae           | Reg Himal        | H  | 2800-3800 | 1,2,6    | -      |
| Corydalis cornuta Royle                         | Fumariaceae           | Reg Himal        | H  | 2400-3500 | 1,2,7,8  | -      |
| Corydalis vaginans Royle                        | Fumariaceae           | Reg Himal        | H  | 2500-2800 | 1,2,7,8  | -      |
| Cotoneaster bacillaris Wall. ex Lindl.*         | Rosaceae              | Reg Himal        | Sh | 1700-3200 | 1,2,3,8  | -      |
| Cryptogramma stellerii (Gmel.) Prantl            | Cryptogrammaceae       | -                | Fn | 2700-4000 | 1,3,9    | -      |
| Cryptolepis buchananii Roem. & Schultes         | Asclepiadaceae        | Ind Or           | Sh | 1300-1800 | 1,3      | -      |
| Cyathula capitata Moq.                          | Amaranthaceae         | Reg Himal        | H  | 1200-2600 | 1,4      | -      |
| Cyathula tomentosa (Roth) Moq.                   | Amaranthaceae         | Reg Himal        | Sh | 1000-2400 | 2,3      | -      |
| Cystopteris fragilis (L.) Bernh.                 | Athyriaceae           | Ind Or           | Fn | 2500-3500 | 1,7,9    | -      |
| Dianthus angulatus Royleex Benth.                | Caryophyllaceae       | Reg Himal        | H  | 2400-3550 | 2,7      | -      |
| Dioscorea bulbifera L.                          | Dioscoreaceae         | Ind Trop         | H  | 1000-1700 | 1,2      | -      |
| Dioscorea belophylla (Prain) Haines             | Dioscoreaceae         | As Trop          | H  | 1000-2100 | 1,2      | -      |
| Diplazium spectabile Ching.                     | Athyriaceae           | -                | Fn | 1800-2400 | 1,5      | -      |
| Dryopteris cochlœata (D. Don) C. Chr.           | Dryopteridaceae       | -                | Fn | 1300-1600 | 1,2,4    | -      |
| Dryopteris panda (C.B. Clarke) Chr.             | Dryopteridaceae       | -                | Fn | 2000-2500 | 1,2,4,5  | -      |
| Elaeagnus conferta Wall. ex Royle               | Elaeagnaceae          | Ind Or           | Sh | 1000-2600 | 1,2,4    | -      |
| Eöppictis helleborine (L.) Crantz               | Orchidaceae           | Reg Himal        | H  | 2500-3650 | 1        | -      |
| Euonymus fimbriatus Wall.                       | Celastraceae          | Reg Himal        | T  | 1200-2800 | 1,2,4,10 | -      |
| Ficus nemoralis Wall.                           | Moraceae              | Reg Himal        | T  | 1000-2000 | 2        | -      |
| Geranium wallachianum D.Don ex Sw.*             | Geraniaceae           | Reg Himal        | H  | 2500-3100 | 1,2,7,8  | -      |
| Geum roylei Wall. ex Bolle                      | Rosaceae              | Reg Himal Bor Occ| H  | 2600-3500 | 1,2,7    | -      |
| Goodyera fusca Hook.f.                          | Orchidaceae           | Reg Himal        | H  | 3000-3900 | 1,8,9    | -      |
| Habenaria pectinata D.Don*                      | Orchidaceae           | Reg Himal        | H  | 1400-3500 | 1        | -      |
| Herpetospermum pedunculosum (Serin.) Cl.        | Cucurbitaceae         | Reg Himal        | H  | 2200-2500 | 1,2      | -      |
| Taxa                          | Family              | Nativity         | LF  | AR (m)  | Habits         | Status |
|------------------------------|---------------------|------------------|-----|---------|----------------|--------|
| Hypoxis aurea Lour.          | Hypoxidaceae        | China            | H   | 1600-2000 | 1,2,4,6        | -      |
| Ilex dipyrena Wall.          | Aquifoliaceae       | Reg Himal        | T   | 1500-2900 | 1,2            | -      |
| Ilex excelsa (Wall.) Hk.     | Aquifoliaceae       | Reg Himal        | T   | 1600-2400 | 1,4            | -      |
| Jasminum dispermum Wall.     | Oleaceae            | Reg Himal        | Sh  | 1500-2000 | 2,4            | -      |
| Jasminum officinale L.       | Oleaceae            | Ind Bor Occ China| Sh  | 1200-3000 | 2,4            | -      |
| Juniperus communis L.        | Cupressaceae        | Reg Bor Temp et Arct | Sh | 2800-3500 | 1,6,7,8        | -      |
| Juniperus indica Bertol.     | Cupressaceae        | Europ            | Sh  | 3000-3600 | 1,7,8          | -      |
| Lonicera myrtillus Hk.f.& Th.| Caprifoliaceae      | Reg Himal        | Sh  | 2800-3100 | 1,2,10         | -      |
| Lonicera obovata Royle ex Hk.f.* | Caprifoliaceae    | Reg Himal        | Sh  | 2700-3100 | 1,3            | -      |
| Lonicera quinquelocularis Hardw. | Caprifoliaceae    | Reg Himal        | Sh  | 1000-2500 | 1,2,9          | -      |
| Lyonia ovalifolia (Wall.) Drude | Ericaceae          | China            | T   | 1200-2700 | 1,2,3,9        | -      |
| Marsdenia lucida Hk.f. & Thom.| Asclepiadaceae     | Reg Himal Nepal  | Sh  | 980-1300  | 1,3            | -      |
| Meconopsis aculeata Royle*   | Papaveraceae        | Reg Himal        | H   | 3200-3500 | 7,8            | EN     |
| Melia azedarach L.           | Meliaceae           | Reg Himal        | T   | 1000-1500 | 1              | -      |
| Meliosma dillenifolia Walp.  | Sabiaceae           | Reg Himal        | T   | 1800-2600 | 1,2,4          | -      |
| Morina coulteriana Royle*    | Morinaceae          | Reg Himal        | H   | 2960-3455 | 1,7,8          | -      |
| Morina longifolia Wall. ex DC.* | Morinaceae         | Reg Himal        | H   | 2500-4000 | 3,7,8          | -      |
| Myrica esculenta Buch.-Ham. ex D.Don | Myricaceae        | As Trop et Subtrop | T  | 1300-2600 | 1,2,4,5        | -      |
| Neottia listeroides Lindl.   | Orchidaceae         | Reg Himal        | H   | 1800-3600 | 1              | -      |
| Ophioglossum petiolatum Hk.  | Ophioglossaceae     | Temp Amer Afr Europ As | H  | 2400-3000 | 1,7,8          | -      |
| Parnassia asarifolia Vent.   | Parnassiaceae       | Temp Amer Afr    | H   | 1000-1600 | 1,2,4          | -      |
| Peristrophe bicalyculata (Retz.) Nees | Acanthaceae     | As et Afr Trop   | H   | 970-1400  | 2,4            | -      |
| Phyllanthus emblica L.       | Euphorbiaceae       | As Trop          | T   | 1500-3000 | 1,3,9          | -      |
| Phytolacca acinosa Roxb.     | Phytolaccaceae      | Reg Himal China  | H   | 2600-3700 | 1,3,5          | -      |
| Pimpinella acuminata (Edgew.) Cl.* | Apiaceae           | Reg Himal        | H   | 2000-3200 | 2,3,5          | -      |
| Pimpinella diversifolia DC.  | Apiaceae            | Reg Himal China  | H   | 2000-3200 | 2,3,5          | -      |
| Taxa                                      | Family            | Nativity          | LF  | AR (m) | Habitats | Status |
|-------------------------------------------|-------------------|-------------------|-----|--------|----------|--------|
| *Plantago himalaica* Pilger*              | Plantaginaceae    | Reg Himal         | H   | 1100-3000 | 1,2      | -      |
| *Polygonatum cirrhifolium* (Wall.) Royle | Liliaceae         | Reg Himal As Bor  | H   | 1800-2300 | 1,5,10   | EN     |
| *Polygonum hydropiper* L.                | Polygonaceae      | Reg Temp Bor et Aust | H   | 980-2400 | 1,5,11   | -      |
| *Polygonum recumbens* Royle ex Bab.      | Polygonaceae      | Reg Himal         | H   | 1400-3000 | 2,3,4     | -      |
| *Polystichum nepalense* Spreng.          | Dryopteridaceae  | -                 | Fn  | 2000-2600 | 1,2,5     | -      |
| *Polystichum lachenense* (Hook.) Bedd.   | Dryopteridaceae  | -                 | Fn  | 2800-3500 | 1,6      | -      |
| *Potentilla eriocarpa* Wall. ex Lehm.*   | Rosaceae          | Reg Himal         | H   | 2600-3600 | 1,7,8     | -      |
| *Potentilla fulgens* Wall.               | Rosaceae          | Reg Himal         | H   | 2000-3200 | 1,3,7     | -      |
| *Primula elliptica* Royle                | Primulaceae       | Reg Himal         | H   | 3600-4000 | 7,8      | -      |
| *Primula involucrata* Wall.              | Primulaceae       | Reg Himal         | H   | 3000-4000 | 7,8      | -      |
| *Primula rosea* Royle*                   | Primulaceae       | Reg Himal         | H   | 2500-4000 | 1,7,8     | -      |
| *Prunus cerasoides* D. Don               | Rosaceae          | Reg Himal         | T   | 2790-3200 | 1,2      | -      |
| *Pteris pseudoquadriaurita* Khullar      | Pteridaceae       | -                 | Fn  | 1000-2400 | 1,2,4,5   | -      |
| *Pteris quadriaurita* Retz.              | Pteridaceae       | -                 | Fn  | 1000-2400 | 1,2,5     | -      |
| *Quercus leucotrichophora* A. Camus      | Fagaceae          | Reg Himal         | T   | 1000-2600 | 1,2,4     | -      |
| *Rhodiola himalensis* (D.Don) S.H. Fu    | Crassulaceae      | Reg Himal         | H   | 3000-4100 | 1,2,3,8   | -      |
| *Rhododendron anthopogon* D.Don*         | Ericaceae         | As Bor Reg Himal  | Sh  | 3000-4100 | 7,8      | VU     |
| *Rhododendron arboreum* Sm.              | Ericaceae         | Ind Or Reg Himal Zeylan | T   | 1000-2300 | 1,2,4     | -      |
| *Rhododendron campanulatum* D.Don*       | Ericaceae         | Reg Himal         | Sh  | 2600-3100 | 1,2,8,10 | VU     |
| *Rhus javanica* L.                       | Anacardiaceae     | Reg Himal China  | T   | 1200-2500 | 2,4      | -      |
| *Rhus parviflora* Roxb.                  | Anacardiaceae     | Reg Himal         | Sh  | 980-1350  | 2        | -      |
| *Ribes glaciale* Wall.                   | Grossulariaceae   | Reg Himal         | Sh  | 2000-3000 | 1,2,10    | -      |
| *Ribes himalense* Royle ex Decne.        | Grossulariaceae   | Europ Afr Bor Reg Himal | Sh  | 2700-3100 | 1,2,3,9,10 | -      |
| *Rorippa indica* (L.) Hiern              | Brassicaceae      | Ind Or China Malaya | H  | 1800-2300 | 1,2      | -      |
| *Rosa webbiana* Wall. ex Royle*          | Rosaceae          | Reg Himal         | Sh  | 2300-3800 | 2,8,10    | -      |
| Taxa                          | Family           | Nativity          | LF | AR (m) | Habitats | Status |
|-------------------------------|------------------|-------------------|----|--------|----------|--------|
| Roscoea purpurea Sm.          | Zingiberaceae    | Reg Himal Burma   | H  | 2000-3000 | 1.7,10 | HP GB  |
| Rubia manjith Roxb. Ex Fleming| Rubiaceae        | As Trop et Temp Afr | Sh | 2000-2500 | 1.2,10 | - -    |
| Rubus paniculatus Sm.*        | Rosaceae         | Reg Himal         | Sh | 1000-2500 | 2.4,10 | - -    |
| Rumex acetosa L.              | Polygonaceae     | Europ As Borv     | H  | 1000-3100 | 1.2,4,6 | - -    |
| Salix tetrasperma Roxb.       | Salicaceae       | Ind Or Malaya     | T  | 1500-2300 | 1.2,3  | - -    |
| Salix wallichiana Anders.     | Salicaceae       | Reg Himal         | T  | 1500-2800 | 1.2    | - -    |
| Salvia nubicola Wall.         | Lamiaceae        | Europ Austr Or    | H  | 1400-2200 | 1.2,10 | - -    |
| Sanicula elata Buch.-Ham. ex D.Don | Apiaceae      | Europ As Bor Afr Austr | H  | 2300-3200 | 1.2    | - -    |
| Satyrium nepalense D.Don*     | Orchidaceae      | Reg Himal         | H  | 1500-3200 | 1.7    | - -    |
| Saussurea atkinsonii Cl.      | Asteraceae       | Reg Himal         | H  | 3200-4100 | 8.9    | - -    |
| Saussurea albescens (DC.) Sch.-Bip.* | Asteraceae     | Reg Himal         | H  | 3000-3500 | 1.3    | - -    |
| Saussurea deltoidea (DC.) Sch.-Bip. | Asteraceae    | Reg Himal         | H  | 2800-3300 | 7.8,9  | - -    |
| Saussurea fastuosa (Decne) Sch.-Bip.* | Asteraceae  | Reg Himal         | H  | 2800-3300 | 1.3,7  | - -    |
| Saussurea heteromala (D. Don) Hand.-Mazz. | Asteraceae | Reg Himal         | H  | 2800-3000 | 1.7,8  | - -    |
| Saxifraga sibirica L.         | Saxifragaceae    | As Bor et Arct    | H  | 3000-3850 | 2.3    | - -    |
| Scrophularia himalensis Royle*| Scrophulariaceae | Reg Himal         | H  | 2200-2700 | 1.2,7  | - -    |
| Selinum candollii DC.*        | Apiaceae         | Reg Himal         | H  | 2000-4000 | 1.6    | - -    |
| Selinum tenatifolium Wall.*   | Apiaceae         | Reg Himal         | H  | 2600-3100 | 1.2,7  | - -    |
| Selinum vagnatum (Edgew.) Cl. | Apiaceae         | Reg Himal         | H  | 2600-3100 | 1.2,4  | - -    |
| Senecio cappa Buch.-Ham. ex D.Don | Asteraceae     | Reg Himal         | H  | 2400-2800 | 7.8    | - -    |
| Sorbus foliolsa (Wall.) Spach*| Rosaceae         | Reg Himal         | Sh | 2700-3800 | 1.10   | - -    |
| Spiranthes sinensis (Pers.) Ames. | Orchidaceae   | China As Temp     | H  | 1100-2800 | 1.4    | - -    |
| Stellaria himalayensis Majundar* | Caryophyllaceae | Reg Himal         | H  | 1500-2800 | 2.9    | - -    |
| Stellaria monosperma D.Don*   | Caryophyllaceae  | Reg Himal         | H  | 1700-2700 | 1.3,9  | - -    |
| Strobilanthes wallichii Nees* | Acanthaceae     | Reg Himal         | H  | 2000-2800 | 1.3,9  | - -    |
| Taxa                        | Family               | Nativity | LF  | AR (m) | Habitats  | Status |
|-----------------------------|----------------------|----------|-----|--------|-----------|--------|
| **Swertia alternifolia** Royle | Gentianaceae         | Reg Himal | H   | 2800-3300 | 7.8       | -      |
| **Swertia cuneata** D.Don*  | Gentianaceae         | Reg Himal | H   | 3200-4100 | 7.8       | -      |
| **Swertia paniculata** Wall.* | Gentianaceae         | Reg Himal | H   | 2000-3500 | 1,2,7,8   | -      |
| **Swertia petiolata** D.Don | Gentianaceae         | Reg Himal | H   | 3800-4100 | 1,7,8     | -      |
| Thalictrum foliolosum DC.*  | Ranunculaceae        | Reg Himal | H   | 1700-3300 | 1,2,3,8   | -      |
| **Thymus linearis** Benth.  | Lamiaceae            | Europ As et Afr Bor | H | 2000-3000   | 1,2,3,4,9,10 | -     |
| Thysanolaena maxima Kuntze  | Poaceae              | As Trop   | H   | 1000-1600  | 1,2,5     | -      |
| **Ulmus villosa** Brandis ex Gamble* | Ulmaceae           | Ind Or As Temp | T | 2200-2800   | 1,2,4     | -      |
| **Ulmus wallichiana** Planch.* | Ulmaceae            | Ind Or    | T   | 1500-2200  |           | -      |
| Verbenia officinalis L.     | Verbenaceae          | Europ Mediter | H | 1300-1700  | 1,2,4     | -      |
| **Viburnum cotinifolium** D.Don | Caprifoliaceae       | Am Bor    | Sh  | 2000-2600  | 1,2,3,10  | -      |
| **Viburnum nervosum** D.Don* | Caprifoliaceae       | Reg Himal | Sh  | 2200-3050  | 1,2,4,10  | -      |
| Woodsia cyclophora Hand.-Mazz. | Woodsiaceae         | -        |     | 3200-3500  | 1.7       | -      |

**Abbreviations Used:** AR=Altitudinal Range; CR=Critically Endangered; EN=Endangered; Fn=Fern; GB=Global; H=Herb; HP=Himachal Pradesh; LC=Least Concern; LF=Life Form; N=Nativity; R=Rare; Sh=Shrub; SR=Site Representation; T=Tree; VU=Vulnerable; Nativity: Afr=Africa; Alp=Alpine; Amer=America; Amphig= Amphigaea; Arabs=Arabia; Arct=Arctic; As=Asia; Austral=Australia; Bor=Borealis; et=And; Europ=Europe; Himal=Himalayan; Ind=Indian; Mediterr=Mediterranean; Min=Minor; Occ=Occidentalis; Or=Orientalis; Pacif=Pacific; Reg=Region; Sibir=Siberia; Temp=Temperature; Trop=Tropical; 1=Shady Moist; 2=Dry; 3=Rocky; 4=Degraded; 5=Riverine; 6=Camping site; 7=Alpine grasslands; 8=Dry alpine slope; 9=Bouldary; 10=Shrublands, 11=Marshy; *=Endemic
