# Floristic Diversity of Vascular Plants in Sikles Region of Annapurna Conservation Area, Nepal

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Abstract

Scientific investigation of floristic diversity is an essential prerequisite for conservation, management and sustainable utilization. The present study was conducted to explore the floristic diversity and life forms in Sikles region of Annapurna Conservation Area. Repeated field surveys with vegetation sampling and herbarium collection were done to find out floristic composition of the area. The study documented a total of 295 vascular plant species belonging to 238 genera and 107 families, including 25 species of fern and fern allies, five species of gymnosperms and 265 species of angiosperms. Herbs were dominant life form with 192 species followed by trees with 50 species whereas shrubs and climbers were 35 and 18 respectively. Asteraceae and Rosaceae (18 species each), Poaceae (17 species), Orchidaceae (16 species), Ranunculaceae (nine species) and Asparagaceae (eight species) were found to be dominant families in the region. *Impatiens* was the largest genera with five species followed by *Rubus* (four species). *Begonia*, *Berberis*, *Swertia* had three species each. The life form classification shows the dominance of phanerophytes (29.27 %), therophytes (24.46 %) and chamaephytes (17.37 %) in the region. The rich flora of different taxonomic categories with both Eastern and Western Himalayan elements reflects the floristic importance of the region.

**Keywords:** Conservation, Eastern Himalaya, Flora, Life forms, *Nardostachys jatamansi*, Protected area

## Introduction

Biodiversity is the heritage of millions of years of evolution. The enormous variety of life on earth is the result of complex interactions among all living organisms including microscopic species (Dirzo & Raven, 2003). Himalayan region, with long altitudinal gradients and climatic complexities, is considered as the biodiversity hotspot with rich vegetation, community and floral diversity (Sharma et al., 2014). The diversity of native flora is an important component of terrestrial ecosystems that has a primary role in protecting the environmental stability of a region (Lohbeck et al., 2016). Biodiversity is important for our survival as it provides us with various ecosystem services and goods (Chaudhary, 1998).

Human activities are continuously changing the world’s terrestrial, freshwater and marine ecosystems and these changes are resulting in the loss of many species (Chapin et al., 2000) which calls for biodiversity conservation. The first and foremost step in this direction is to measure biodiversity occurring in various regions of the earth periodically. A measure of number of species present (species richness) at a given site, in a given area or country and, ultimately, in the whole world, is still the most straightforward and, in many ways, the most useful measure of biodiversity (Shaheen et al., 2012).

Floristic study refers to the documentation of all plant species in a given geographical region (Simpson, 2006). Floristic study is necessary to understand the present diversity status and conservation of forest biodiversity. It has been realized that the study of local or regional flora is of much more significance than those covering big areas because explorations can be carried out intensively in small areas. Understanding species diversity and distribution patterns is important to evaluate the complexity and resources of these forests. Floristic studies include species lists, life-form spectra, geographical distribution, and identification of threatened species that are useful for evaluating ecological issues such as biodiversity, growth capacity, conservation and regulation (Ali et al., 2018). Thus, floristic studies could provide valuable data which could be used as reference for future studies. The results of such floristic works mostly come in the form of floras (Palmer et al., 1995) which may be local, regional or national. According to Takhtajan (1986), Nepal lies in transitional zone between Eastern and Western Himalayan flora; therefore, due to the topographic and climatic variations, high diversity of vascular plants can be seen in different parts of the country.

Raunkiaer (1934) proposed the term “Biological Spectrum” to express both the life form distribution in a flora and the phytoclimate under which the prevailing life forms evolved. Life form study is thus an important part of vegetation description, ranking next to floristic composition. The basic life form categories include phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes (Raunkiaer, 1934). Life forms depend on genetic as well as environmental factors because the environmental factors can affect the formation of different critical forms of plants (Shah et al., 2013). Accordingly, in different communities and different regions, plants can have different life forms. The biological spectrum is helpful in comparing geographically far and widely separated plant communities, and is used as an indicator of prevailing environment.

The aim of this study was to explore the floristic composition and plant diversity as well as to find out biological life form spectrum of plants in Sikles region, the southern part of Annapurna Conservation Area, which will help to outline further conservation measures to protect the diversity of the area.

## Materials and Methods

### Study site

The study was carried out in the Sikles area of Madi Rural Municipality located in the southern part of Annapurna Conservation Area, Kaski District, Gandaki Province. Diverse forest patterns are found in nearby Parche and Sikles villages providing communities with basic services. The forest floor is uneven and elevation ranges from 2000 to 3300 m asl. Geographically, it is located within the coordinate range of 28°28'N-28°47'N latitude and 84°00'E-84°42'E longitude (Figure 1).

The climate of the study area ranges from upper subtropical to lower alpine mostly covering temperate region. The climate is influenced by monsoon with temperate climate in lower elevation while subalpine in higher elevation. Records of Department of Hydrology and Meteorology for the last 8 years (2010-2017) shows maximum annual temperature of 21.9°C and minimum of 12.2°C. The average annual precipitation is 575 mm with maximum mean precipitation of 1020.25 mm in July (Department of Hydrology & Metrology [DHM], 2018).

According to the altitudinal zone and climatic variations *Alnus* forests, mixed forests, broad leaved forests, evergreen forests and bushes and grasslands are seen in the area. Lower area of dense canopy forest and higher alpine meadow area creates suitable habitats for different ungulate species of animals.

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**Figure 1:** Land use classification map of the study area

### Research approval

Prior to undertaking the research, the objectives were discussed with the management authorities of Annapurna Conservation Area. The permission for field work was taken from the Department of National Parks and Wildlife Conservation (DNPWC) and Annapurna Conservation Area Project (ACAP).

### Field survey

The field study was carried out from June 2018 to January 2019 within the elevation range of 2000-4000 m asl covering different habitat types and vegetation zones. Data on floristic composition of the area were collected by stratified random sampling (Behera et al., 2005; Panthi et al., 2007). The study area within altitudinal range of 2000-4000 m asl was divided into six sampling sites characterizing different altitudes, forest types and habitats. The sites were Raising Danda, Mouja-Prolu, Thasa Kharka, Chyomi, Tinje and Kori. Altogether 60 plots (10 m × 10 m) were studied in six sampling sites (10 in each). Sampling plots within the sites were selected using reference site such as walking trail. The distance between two plots in each sampling site was approximately 100 m asl.

Raising Danda site was located within the altitudinal range of 2000-2300 m asl. The vegetation was mostly dominated by *Alnus nepalensis* and the community composed of *Daphniphyllum himalayense, Viburnum erubescens* and *Brucea javanica*. The altitudinal range of Mouja-Prolu was 2300 2600 m asl. The mixed forest type was seen in this range with the species of *Symplocos ramosissima*, *Eurya acuminate*, *Lyonia ovalifolia* and *Elaeagnus parvifolia*. Tasha Kharka area was located in the altitudinal range of 2600‑2800 m asl. Species such as *Ilex dipyrena*, *Hydrangea heteromalla* and *Acer cappadocicum* were found with *Rhododendron arboreum*. Chyomi area, lying within the altitudinal range of 2800‑3200 m asl, constituted mainly of Oak-*Rhododendron* forest. The dominant tree species in this site were *Rhododendron arboreum* and *Quercus semecarpifolia*. Tinje area, located within 3200- 3600 m asl altitudinal range, was mostly covered by shrubby vegetation of *Rosa sericea* and *Berberis concinna* with *Rhododendron campanulatum*.Kori area, with altitudes from 3700 m asl to 4000 m asl, was mostly presenting grasses with scattered *Rhododendron campanulatum*. This area was very sloppy with large rocks cliffs.

### Sample collection and identification

Voucher specimens of all vascular plants, either in flowering or fruiting stage, were collected to prepare herbarium specimens (Rajbhandari & Rajbhandary, 2015). All vouchers were taken to the laboratory for identification with the help of detailed field data collected during the field trips. The herbarium specimens were deposited in Tribhuvan University Central Herbarium (TUCH).

Identifications of voucher specimens were carried out by following standard literatures (Grierson & Long, 1983-2001; Polunin & Stainton, 1984; Stainton, 1988; Press et al., 2000; Fraser-Jenkins, 2015; Rajbhandari & Rai, 2017), expert consultation and visit to the National Herbarium and Plant Laboratories (KATH) and Tribhuvan University Central Herbarium (TUCH). Nomenclature follows the Catalogue of Life (Roskov et al., 2019) and Plants of the World Online (http://www.plantsoftheworldonline.org). The plants were classified into different life forms following Raunkiaer (1934) (Table 5).

## Results and Discussion

### Floristic composition

The floristic composition of Sikles region comprised of 295 species belonging to 238 genera and 107 families (Tables 1, 2, 3 and 4). In terms of species, 206 were dicots, 59 were monocots, 25 were ferns and five were Gymnosperms (Figure 2). Asteraceae and Rosaceae were dominant families with 18 species each followed by Poaceae (17 species), Orchidaceae (16 species), Ranunculaceae (nine species) and Asparagaceae (eight species). Polygonaceae, Fabaceae, and Lamiaceae (seven species each) were among other families with most species (Figure 3). The present findings are similar to those of Chalise et al. (2019) in Gyasumbdo valley Manang, a territory within Annapurna Conservation Area, where dicots were dominant with Asteraceae as dominant family. However, results differ in monocots, where Orchidaceae was dominant family in Manang, whereas Poaceae was dominant family in the present study. Major parts of the present study area were located in higher altitude mostly covered by the grasses and with scattered *Rhododendron campanulatum*.

Among 14 families of Pteridophytes, Pteridaceae (3 genera, 5 species) was found to be the largest family, while in case of Gymnosperms, Pinaceae (2 genera, 2 species) was found to be the largest family. Similar results were also reported by Chalise et al*.* (2019).

Floristic study revealed that dicots (206 species) were the most diverse group followed by monocots (59 species) in terms of species composition. *Impatiens* was the largest genus with 5 species followed by 4 species of *Rubus*. *Begonia*, *Berberis* and *Swertia* had 3 species each. Based on plant habits, 192 (65%) species were herbs, 50 (17%) species were trees and 35 (12%) species were shrubs while climbers included 18 (6%) species (Figure 4).

The study area lies near to Kali Gandaki River which separates the Eastern and Western Himalayan floristic regions. The summer rainfall is high in this area. Therefore, the area is rich with the assemblage of both Eastern and Western floristic elements with some other unique species such as *Alsophila spinulosa*, *Dolomiaea macrocephala*, *Meconopsis regia* and *Hymenidium benthamii*. In the context of the floral diversity, the vegetation is mostly dominated by the Eastern Himalayan elements such as species of *Aconitum*, *Berberis*, *Calanthe*, *Cicerbita*, *Corydalis*, *Potentilla*, *Rubus*, *Saxifraga*, *Delphinium*, and *Impatiens* with other some Western Himalayan elements such as species of *Abies*, *Quercus* (Takhtajan, 1986; Welk, 2015; Chalise et al., 2019). The differing flora of the East Himalaya and the West Himalaya merge in Central Nepal.

Some potentially high value medicinal plants such as *Aconitum gammiei*, *Bergenia ciliata*, *Dactylorhiza hatagirea*, *Paris polyphylla*, *Picrorhiza scrophulariiflora*, *Rheum australe* and *Swertia chirayta* were also recorded. Among the documented species, 17 species had been included in one of the categories of Conservation Assessment and Management Plan (CAMP) (Bhattarai et al., 2002). Two species (*Taxus wallichiana* and *Nardostachys jatamansi* had been included in International Union for Nature Conservation (IUCN) red list categories (IUCN, 2019). Five species had been included in the *Convention on International Trade in Endangered Species* of Wild Fauna and Flora (CITES) list (UNEP-WPMC, 2018). Species such as *Dactylorhiza hatagirea*, *Picrorhiza scrophulariiflora*, *Swertia chirayta* and *Rubia manjith* which had been included in government list of medicinal plants prioritized for research and development (Gurung & Pyakurel, 2017), were also documented during this study (Table 6).

**Figure 2:** Number of families, genera and species of plant groups



**Figure 3:** Dominant families in study area



**Figure 4:** Habits of plants

### Life form classes

A total of 283 species were classified based on life forms in different categories (species which identified up to species level). The life form classes showed that phanerophytes (82 species, 29.07%), therophytes (69 species, 25%) and chamaephytes (49 species, 17.37%) were the most abundant life forms. They were followed by cryptophytes (46 species, 16.25%) and hemicryptophytes (37 species, 13.12%) (Figure 5). *Cuscuta reflexa* was the only parasitic species. The life form is an important physiognomic attribute that has been widely used in vegetation studies (Khan et al., 2013). It indicates micro- and macroclimate as well as human disturbance of a particular area. The life form of plant species reflects the adaptation of plants to the climatic conditions (Shah et al., 2013).

The domination of phanerophytes and therophytes over other life forms observed during this study seems to be a response to the topographic divergence, human being and creature disturbance. It also indicates the temperate type (warm and moist) of climate in the study area. The result is contrasting from the study of Joshi et al. (2015) in Nyeshang valley of Manang district within Annapurna Conservation Area where chamaephytes were dominant followed by hemicryptophytes and phenerophytes. Several studies had shown that phanerophytes and therophytes dominance over other life forms might be due to harsh climate and the anthropogenic pressure such as fuel wood collection, grazing, forest fire, lopping and felling of the trees (Khan et al., 2013). Chamaephytes and hemicryptophytes are considered indicators of unfavorable environment and highly vulnerable to any environmental change (Joshi et al., 2015).

Floristic investigations along with life form classification provide reliable information about the nomenclature, distribution, ecology and utility of various plant species. It has been realized that intensive rather than extensive floristic studies of different geographical region are necessary for the proper documentation, conservation plans and sustainable utilization of plant resources (Ali et al., 2018). Due to recurrent forest fires, indiscriminate exploitation of forest resources, destruction of forest areas for construction and introduction of invasive exotic species, several native species are under pressure and may face threat of extinction in future. The description and identification of plants in an area is very important because it shows distinct species in an area and their occurrence in the growing season. Such assessment also helps to identify the ecological vulnerability of the area and to suggest conservation priority (Uprety et al., 2011). It also helps in finding new species of the area and their adjustment in local climatic condition (Ali, 2008).

## Conclusion

This study provides fundamental information about the flora of the Sikles region of Annapurna Conservation Area by means of a thorough botanical inventory. Asteraceae and Poaceae were found to be the largest families of dicots and monocots respectively. Likewise, Pinaceae was found to be the largest family of Gymnosperms and Pteridaceae was found to be the largest family of Pteridophytes. The dominance of phanerophytic and therophytic life forms showed that the area was under heavy biotic pressure. These findings could have special significance for further ecological research and for recommendations of proper guidance for the management, reclamation, and development of the area and other similar regions. Describing the floristic composition of a habitat is valuable for continuation of ecological research, management and conservation of plants. Presence of numerous species of *Aconitum*, *Berberis*, *Delphinium*, *Impatiens*, *Potentilla* and *Saxifraga* represents the dominance of Eastern Himalayan floristic elements.

## Author Contributions

All the authors were involved in concept development, research designing, defining of intellectual content and literature research. D. Khakural and Y. Upreti collected and analysed data, and prepared manuscript. S. Rajbhandari edited and reviewed the manuscript. Y. Upreti, as a corresponding author, is the guarantor for this article.

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**Table 1:** List of dicotyledons

| **S.N.** | **Family** | **Scientific Name** | **Collection Number** | **Life Forms** | **Habits** |
| --- | --- | --- | --- | --- | --- |
| 1 | Acanthaceae | *Achyranthus aspera* L.  | KSD391 | TH | H |
| 2 | *Asystasia macrocarpa* Wall. ex Nees |  | TH  | H |
| 3 | *Strobilanthes lachenensis* C. B. Cl. | KSD387 | TH | H |
| 4 | Acoraceae | *Acorus calamus* L. |  | CR | H |
| 5 | Actinidiaceae | *Saurauia napaulensis* DC. | KSD19 | PH | T |
| 6 | Adoxaceae | *Viburnum erubescens* Wall. | KSD112 | PH | T |
| 7 | *Viburnum mullaha* Buch.-Ham. ex D. Don  | KSD105 | PH | T |
| 8 | Amaranthaceae | *Amaranthus spinosus* L.  | KSD392 | TH | H |
| 9 | *Chenopodium album* L. | KSD399 | TH | H |
| 10 | Anacardiaceae | *Choerospondias axillaris* (Roxb.) B.L. Burtt & A.W. Hill  |  | PH | T |
| 11 | *Rhus succedanea* L. | KSD89 | PH | T |
| 12 | Apiaceae | *Centella asiatica* (L.) Urb. | KSD43 | CH | H |
| 13 | *Hymenidium benthamii* (Wall. ex DC.) M.G. Pimenov & E. V. Kljuykov | KSD28 | CH | H |
| 14 | *Cortia depressa* (D. Don) C. Norman | KSD587 | HE | H |
| 15 | *Selenium* sp. | KSD598 |  | H |
| 16 | Apocyanaceae | *Ceropegia pubescens* Wall. |  | CH | C |
| 17 | Aquifoliaceae | *Ilex dipyrena* Wall. | KSD30 | PH | T |
| 18 | Araliaceae | *Trevesia palmata* (Roxb. ex Lindl.) Vis. | KSD | PH | T |
| 19 | *Hedera nepalensis* K. Koch  | KSD103 | HE | C |
| 20 | Asteraceae | *Ageratina adenophora* (Spreng.) R. King & H. Rob. |  | CH | H |
| 21 | *Anaphalis busua* (Buch.-Ham. ex D. Don) DC. | KSD808 | CH | H |
| 22 | *Anaphalis contorta* (D. Don) Hook. fil. | KSD71 | CH | H |
| 23 | *Anaphalis triplinervis* (Sims) C. B. Cl.  | KSD806 | CH | H |
| 24 | *Bidens pilosa* L. |  | TH | H |
| 25 | *Cirsium verutum* (D. Don) Spreng. | KSD803 | TH | H |
| 26 | *Crassocephalum crepidioides* (Benth.) S. Moore. |  | TH | H |
| 27 | *Cremanthodium reniforme* (Wall. ex DC.) Benth.  | KSD809 | CH | H |
| 28 | *Duhalde acappa* (Buch.-Ham. ex D. Don) Pruski & Anderberg | KSD815 | PH | S |
| 29 | *Senecio graciliflorus* (Wall.) DC. | KSD854 | TH | H |
| 30 | *Ligularia fischeri* (Ledeb.) Turcz. | KSD824 | TH | H |
| 31 | *Cicerbita macrorhiza* (Royle) Beauv. | KSD855 | TH | H |
| 32 | *Pseudognaphalium affine* (D. Don) A. Andeb.  | KSD863 | TH | H |
| 33 | *Dolomiaea macrocephala* Royle |  | CH  | H |
| 34 | *Taraxacum officinale* (L.) Weber. | KSD63 | TH | H |
| 35 | *Ageratum conyzoides* L.  |  | TH | H |
| 36 | *Leontopodium stracheyi* (Hook. f.) C. B. Cl. ex Hemsl. | KSD856 | CH | H |
| 37 | *Artemisia indica* Willd. | KSD05 | HE | H |
| 38 | Balsaminaceae | *Impatiens edgeworthii* Hook. fil. | KSD781 | CH | H |
| 39 | *Impatiens racemosa* DC. | KSD782 | CH | H |
| 40 | *Impatiens* sp.  | KSD783 |  | H |
| 41 | *Impatiens sulcata* Wall. | KSD784 | CH | H |
| 42 | *Impatiens urticifolia* Wall. | KSD785 | CH | H |
| 43 | Begoniaceae | *Begonia dioica* Buch.-Ham. ex D. Don | KSD97 | TH | H |
| 44 | *Begonia palmata* D. Don | KSD99 | TH | H |
| 45 | *Begonia picta* Sm. | KSD98 | TH | H |
| 46 | Berberidaceae | *Berberis aristata* DC. | KSD06 | PH | S |
| 47 | *Berberis concinna* Hook. fil. | KSD791 | PH | S |
| 48 | *Berberis napaulensis* (DC.) Spreng. |  | PH | S |
| 49 | Betulaceae | *Alnus nepalensis* D. Don. | KSD07 | PH | T |
| 50 | *Betula utilis* D. Don |  | PH | T |
| 51 | Boraginaceae | *Cynoglossum zeylanicum* (Vahl) Thunb. ex Lehm. | KSD45 | TH | H |
| 52 | *Cynoglossum* sp.  | KSD223 |  | H |
| 53 | *Maharanga emodi* (Wall.) A. DC. | KSD107 | TH | H |
| 54 | *Maharanga bicolor* (Wall.ex G. Don) A. DC. | KSD793 | TH | H |
| 55 | Campanulaceae | *Lobelia pyramidalis* Wall. | KSD46 | TH | H |
| 56 | Cannabaceae | *Cannabis sativa* L. | KSD47 | CH | S |
| 57 | Caprifoliaceae | *Nardostachys jatamansi* (D. Don) DC.  |  | CR | H |
| 58 | *Dipsacus inermis* Wall. | KSD786 | TH | H |
| 59 | Caryophyllaceae | *Stellaria* sp.  | KSD788 | TH | H |
| 60 | *Drymaria cordata* (Blume) J.A. Duke | KSD792 | CR | H |
| 61 | Celastraceae | *Parnassia nubicola* Wall. ex Royle | KSD797 | HE | H |
| 62 | Convolvulaceae | *Cuscuta reflexa* Roxb. |  | P  | C |
| 63 | Crassulaceae | *Rhodiola bupleuroides* (Wall. ex Hook. fil. &Thoms.) Fu | KSD767 | CH | S |
| 64 | Cucurbitaceae | *Herpetospermum pedunculosum* (Ser.) C.B. Clarke | KSD675 | TH | C |
| 65 | *Solena amplexicaulis* (Lam.) Gandhi | KSD48 | TH | C |
| 66 | *Trichosanthes tricuspidata* Lour.  | KSD776 | TH | C |
| 67 | Daphniphyllaceae | *Daphniphyllum himalayense* (Benth.) Mull. Arg. | KSD772 | PH | T |
| 68 | Elaeagnaceae | *Elaeagnus infundibularis* Momiy. | KSD11 | PH | T |
| 69 | Ericaceae | *Lyonia ovalifolia* (Wall.) Drude | KSD13 | PH | T |
| 70 | *Rhododendron arboreum* Sm. | KSD100 | PH | T |
| 71 | *Rhododendron campanulatum* D. Don  | KSD103 | PH | T |
| 72 | *Vaccinium nummularia* Hook. Fil & b Thoms. ex C.B. Cl. | KSD101 | HE | H |
| 73 | Euphorbiaceae | *Euphorbia royleana* Boiss. | KSD768 | PH | S |
| 74 | *Macaranga denticulata* (Blume) Mull. Arg | KSD762 | PH | T |
| 75 | Fabaceae | *Parochetus communis* D. Don |  | TH | H |
| 76 | *Erythrina arborescens* Roxb.  | KSD761 | PH | T |
| 77 | *Desmodium elegans* DC.  | KSD751 | TH | S |
| 78 | *Desmodium* sp.  | KSD752 |  | S |
| 79 | *Crotalaria* sp.  | KSD755 |  | H |
| 80 | *Piptanthus nepalensis* (Hook.) D.Don | KSD102 | PH | S |
| 81 | *Indigofera heterantha* Wall. ex Brandis | KSD82 | PH | S |
| 82 | Fagaceae | *Castanopsis indica* (Roxb. ex Lindl.) A.DC. |  | PH | T |
| 83 | *Quercus galuca* Thunb. | KSD31 | PH | T |
| 84 | *Quercus semecarpifolia* Sm.  | KSD735 | PH | T |
| 85 | Gentianaceae | *Gentiana depressa* D. Don | KSD388 | HE | H |
| 86 | *Halenia elliptica* D. Don | KSD70 | TH | H |
| 87 | *Swertia angustifolia* Buch.-Ham. ex D. Don  | KSD51 | TH | H |
| 88 | *Swertia chirayta* (Roxb.) Karst. | KSD50 | HE | H |
| 89 | *Swertia paniculata* Wall. | KSD78 | TH | H |
| 90 | *Gentiana capitata* Buch.-Ham. ex D. Don | KSD65 | HE | H |
| 91 | Geraniaceae | *Geranium* sp. | KSD731 |  | H |
| 92 | *Geranium wallichianum* D. Don ex Sweet | KSD732 | CH | H |
| 93 | Gesneriaceae | *Aeschynanthus hookeri* C.B. Clarke |  | TH | H |
| 94 | *Chirita pumila* D. Don  | KSD736 | TH | H |
| 95 | *Didymocarpus primulifolius* D. Don  | KSD115 | TH | H |
| 96 | Grossulariaceae | *Ribes himalense* Royle ex Decne.  | KSD91 | PH | T |
| 97 | Hydrangeaceae | *Hydrangea febrifuga* (Lour.) Y. De Smet & Granados  | KSD113 | TH | S |
| 98 | *Hydrangea heteromalla* D. Don | KSD84 | PH | T |
| 99 | Hypericaceae | *Hypericum elodeoides* Choisy | KSD676 | TH | H |
| 100 | *Hypericum japonicum* Thunb. | KSD373 | TH | H |
| 101 | *Hypericum cordifolium* Choisy | KSD273 | PH | S |
| 102 | Juglandaceae | *Juglans regia* L.  |  | PH | T |
| 103 | *Engelhardia spicata* Lesch. ex Bl.  | KSD731 | PH | T |
| 104 | Lamiaceae | *Coolebrokea oppositifolia* Sm.  | KSD36 | PH | S |
| 105 | *Leucosceptrum canum* Sm. | KSD32 | PH | T |
| 106 | *Phlomoides bracteosa* (Royle ex Benth.) Kamelin & Makhm. | KSD724 | TH | H |
| 107 | *Stachys melissifolia* Benth. | KSD721 | TH | H |
| 108 | *Elsholtzia blanda* (Benth.) Benth. | KSD66 | TH | H |
| 109 | *Elsholtzia fruticosa* (D. Don) Rehder | KSD83 | PH | S |
| 110 | *Colquhounia coccinea* Wall.  | KSD805 | PH | S |
| 111 | Lardizabalaceae | *Stauntonia angustifolia* (Wall.) Christenh.  | KSD04 | TH | C |
| 112 | Lauraceae | *Lindera neesiana* (Wall. ex Nees) Kruz | KSD33 | PH | T |
| 113 | *Lindera* sp.  |  | PH | T |
| 114 | *Cinnamomum tamala* (Buch.-Ham.) Th. G. G. Nees | KSD55 | PH | T |
| 115 | Linaceae | *Reinwardtia indica* Dumort. | KSD56 | PH | S |
| 116 | Magnoliaceae | *Magnolia champaca* (L.) Baill. ex Pierre  | KSD14 | PH | T |
| 117 | *Magnolia* sp.  | KSD15 | PH | T |
| 118 | Mazaceae | *Mazus surculosus* D. Don | KSD569 | TH | H |
| 119 | Melanthiaceae | *Paris polyphylla* Sm. | KSD57 | CR | H |
| 120 | Melastomataceae | *Osbeckia stellata* Buch.-Ham. ex D. Don | KSD442 | PH | H |
| 121 | Meliaceae | *Toona ciliata* M. Roem. | KSD802 | PH | T |
| 122 | Moraceae | *Ficus auriculata* Lour. | KSD87 | PH | T |
| 123 | *Ficus religiosa* L. |  | PH | T |
| 124 | *Ficus neriifolia* Sm. | KSD719 | PH | T |
| 125 | *Ficus semicordata* Buch.-Ham. ex Sm. | KSD86 | PH | T |
| 126 | Myricaceae | *Myrica esculenta* Buch.-Ham. ex D. Don | KSD714 | PH | T |
| 127 | Oleaceae | *Chrysojasminum fruticans* (L.) Banfi | KSD657 | PH | S |
| 128 | Onagraceae | *Epilobium brevifolium* D. Don | KSD716 | TH | H |
| 129 | Orobanchaceae | *Pedicularis siphonantha* D. Don | KSD59 | CH | H |
| 130 | Oxalidaceae | *Oxalis corniculata*  L. | KSD707 | CR | H |
| 131 | Papaveraceae | *Corydalis juncea* Wall. | KSD706 | CH | H |
| 132 | *Corydalis* sp. | KSD708 | CH  | H |
| 133 | *Meconopsis paniculatus* (D. Don) Prain | KSD705 | CH  | H |
| 134 | *Meconopsis regia* G. Tayl. |  | HE | H |
| 135 | Pentaphylacaceae | *Eurya acuminata* DC. | KSD35 | PH | T |
| 136 | Phyllanthaceae | *Phyllanthus parvifolius* Buch.-Ham. ex D. Don | KSD08 | PH | S |
| 137 | Phytolaccaceae | *Phytolacca acinosa* Roxb.  | KSD60 | PH | H |
| 138 | Piperaceae | *Piper mullesua* Buch.-Ham. ex D. Don  | KSD42 | TH | C |
| 139 | Plantaginaceae | *Plantago major* L. | KSD701 | TH | H |
| 140 | *Hemipharagma heterophyllum* Wall. | KSD106 | CR | H |
| 141 | *Picrorhiza scrophulariiflora* (Pennell) D.Y. Hong | KSD61 | CR | H |
| 142 | Polygonaceae | *Bistorta macrophylla* (D. Don) Sojak | KSD73 | CR | H |
| 143 | *Fagopyrum acutatum* (Lehm.) Mansf. ex K. Hammer  | KSD101 | TH | H |
| 144 | *Koenigia polystachya* (Wall. ex Meisn.) T.M.Schust. & Reveal | KSD710 | CH  | H |
| 145 | *Rheum acuminatum* Hook. fil. & Thoms. | KSD771 | CH  | H |
| 146 | *Rumex nepalensis* Spreng. | KSD62 | CH  | H |
| 147 | *Rheum australe* D. Don  |  | CH  | H |
| 148 | *Koenigia mollis* (D. Don) T.M.Schust. & Reveal | KSD76 | CH | H |
| 149 | Primulaceae | *Maesa chisia* Buch.-Ham. ex D. Don | KSD34 | PH | S |
| 150 | *Primula denticulata* Sm.  | KSD381 | TH | H |
| 151 | Ranunculaceae | *Anemone rivularis* Buch.-Ham. ex DC. | KSD364 | CH | H |
| 152 | *Clematis buchananiana* DC.  | KSD371 | CH | C |
| 153 | *Thalictrum reniforme* Wall. | KSD359 | CH | H |
| 154 | *Aconitum spicatum* (Brühl) Stapf | KSD365 | TH | H |
| 155 | *Aconitum gammiei* Stapf | KSD366 | CR | H |
| 156 | *Thalictrum foliolosum* DC.  | KSD119 | CR | H |
| 157 | *Delphinium vestitum* Wall. | KSD120 | CR | H |
| 158 | *Delphinium* sp. | KSD116 | CR | H |
| 159 | *Ranunculus sceleratus* L. | KSD351 | TH | H |
| 160 | Rosaceae | *Argentina lineata* (Trevir.) Soják | KSD79 | HE | H |
| 161 | *Neillia thyrsiflora* D. Don. | KSD94 | PH | S |
| 162 | *Potentilla* sp. | KSD356 |  | H |
| 163 | *Potentilla* sp.  | KSD354 |  | H |
| 164 | *Prinsepia utilis* Royle | KSD37 | PH | S |
| 165 | *Pyracantha crenulata* (Roxb. ex D. Don) M.Roemer | KSD26 | PH | S |
| 166 | *Rubus biflorus* Buch.-Ham. ex Sm.  | KSD92 | PH | S |
| 167 | *Rubus ellipticus* Sm.  | KSD87 | PH | S |
| 168 | *Rubus nepalensis* (Hook. fil.) Kuntze | KSD86 | CH | H |
| 169 | *Rubus rosifolius* Sm. | KSD88 | PH | S |
| 170 | *Spiraea bella* Sims. | KSD96 | PH | S |
| 171 | *Potentilla indica* (Andr.) Wolf | KSD345 | HE | H |
| 172 | *Fragaria nubicola* Lindl.  | KSD344 | HE | H |
| 173 | *Rosa sericea* Lindl. | KSD336 | PH | S |
| 174 | *Cotoneaster rotundifolius* Wall. ex Lindley  | KSD95 | CH | S |
| 175 | *Prunus cerasoides* D. Don | KSD16 | PH | T |
| 176 | Rubiaceae | *Galium elegans* Wall. Ex Roxb. | KSD110 | CH | C |
| 177 | *Neohymenopogon parasiticus* (Wall.) Bennet | KSD104 | PH | S |
| 178 | *Rubia manjith* Roxb.  | KSD09 | TH | C |
| 179 | Rutaceae | *Boenninghausenia albiflora* (Hook.) Rchb. ex Meisn. | KSD123 | TH | H |
| 180 | *Zanthoxylum armatum* DC.  | KSD311 | PH  | T |
| 181 | *Zanthoxylum* sp.  | KSD315 | PH | S |
| 182 | Santalaceae | *Pyrularia edulis* (Wall.) A. DC.  | KSD317 | PH  | T |
| 183 | Sapindaceae | *Acer cappadocicum* Gled.  | KSD38 | PH | T |
| 184 | *Acer* sp.  | KSD328 | PH  | T |
| 185 | Saururaceae | *Houttuynia cordata* Thunb. | KSD122 | CR  | H |
| 186 | Saxifragaceae | *Astilbe rivularis* Buch.-Ham. ex D. Don  | KSD121 | CH | H |
| 187 | *Saxifraga brachypoda* D. Don | KSD318 | CH | H |
| 188 | *Saxifraga parnassifolia* D. Don  | KSD321 | CH  | H |
| 189 | *Bergenia ciliata* (Haw.) Sternb. | KSD324 | CR | H |
| 190 | Scrophulariaceae | *Buddleja paniculata* Wall. | KSD308 | PH | S |
| 191 | Simaroubaceae | *Brucea javanica* (L.) Merr. | KSD305 | PH | T |
| 192 | Solanaceae | *Solanum aculeatissimum* Jacq. | KSD304 | TH | H |
| 193 | *Solanum nigrum* L.  | KSD307 | TH | H |
| 194 | *Nicotiana tabacum* L.  | KSD10 | PH | S |
| 195 | Symplocaceae | *Symplocos ramosissima* Wall. | KSD17 | PH | T |
| 196 | Theaceae | *Schima wallichii* Choisy | KSD801 | PH | T |
| 197 | Thymelaeaceae | *Daphne papyracea* Wall. ex Steud.  | KSD03 | PH | S |
| 198 | Urticaceae | *Boehmeria platyphylla* D. Don | KSD306 | CH | H |
| 199 | *Elatostema monandrum* (D. Don) H. Hara | KSD303 | HE | H |
| 200 | *Girardinia diversifolia* (Link) Friis | KSD01 | HE | H |
| 201 | *Urtica dioca* L. | KSD02 | HE | H |
| 202 | *Debregeasia salicifolia* (D. Don.) R. | KSD302 | PH | S |
| 203 | *Pouzolzia sanguinea* (Blume) Merr. | KSD75 | HE | H |
| 204 | Violaceae | *Viola biflora* L.  |  | HE | H |
| 205 | *Viola pilosa* Bl. | KSD64 | HE | H |
| 206 | Vitaceae | *Tetrastigma serrulatum* (Roxb.) Planch. | KSD63 | CH | C |

**Table 2:** List of monocotyledons

| **S.N.** | **Family** | **Scientific Name** | **Collection Number** | **Life Froms** | **Habits** |
| --- | --- | --- | --- | --- | --- |
| 1 | Amryllidaceae | *Allium wallichii* Kunth | KSD97 | CR | H |
| 2 | Araceae | *Arisaema costatum* (Wall.) Mart. |  | CR | H |
| 3 | *Arisaema nepenthoides* (Wall.) Mart. ex Schott | KSD80 | CR | H |
| 4 | Asparagaceae | *Asparagus filicinus* Buch.-Ham. ex D. Don | KSD205 | CR | C  |
| 5 | *Asparagus racemosus* Willd. | KSD20 | CR | C  |
| 6 | *Chlorophytum nepalense* (Lindl.) Baker  | KSD114 | TH | H |
| 7 | *Ophiopogon clarkei* Hook.f.  | KSD109 | TH | H |
| 8 | *Polygonatum cirrhifolium* (Wall.) Royle | KSD21 | TH | H |
| 9 | *Polygonatum punctatum* Royle ex Kunth | KSD93 | TH | H |
| 10 | *Maianthemum purpureum* (Wall.) LaFrankie | KSD85 | TH | H |
| 11 |  *Agave cantala* (Haw.) Roxb. ex Salm-Dyck |  | PH | S |
| 12 | Commelinaceae | *Commelina benghalensis* L.  | KSD206 | CR | H |
| 13 | Cyperaceae | *Carex filicina* Nees | KSD208 | HE | H |
| 14 | *Carex gammiei* (C.B.Clarke) S.R.Zhang & O. Yano | KSD592 | HE | H |
| 15 | *Carex vesiculosa* Boott | KSD408 | HE | H |
| 16 | *Cyperus brevifolius (*Rottb.) Hassk. | KSD209 | HE | H |
| 17 | Dioscoreaceae | *Dioscorea deltoidea* Wall. ex Griseb. | KSD403 | CR | C  |
| 18 | *Dioscorea bulbifera* L. | KSD22 | CR | C  |
| 19 | Juncaceae | *Juncus himalensis* Klotzsch | KSD521 | CR | H |
| 20 | *Juncus thomsonii* Buch. | KSD215 | CR | H |
| 21 | *Luzula multiflora* (Retz.) Lej. | KSD211 | CR | H |
| 22 | Liliaceae | *Cardiocrinum giganteum* (Wall.) Makino |  | TH | H |
| 23 | *Fritillaria cirrhosa* D. Don |  | CR | H |
| 24 | Orchidaceae | *Calanthe tricarinata* Lindl. | KSD216 | CR | H |
| 25 | *Coelogyne corymbosa* Lindl. | KSD578 | CR | H |
| 26 | *Coelogyne cristata* Lindl. | KSD77 | CR | H |
| 27 | *Cymbidium iridioides* D. Don | KSD225 | CR | H |
| 28 | *Dendrobium porphyrochilum* Lindl. | KSD245 | CR | H |
| 29 | *Eria coronaria* (Lindl.) Rchb.f. | KSD228 | HE | H |
| 30 | *Malaxis muscifera* (Lindl.) Kuntze | KSD556 | CR | H |
| 31 | *Neottia pinetorum* (Lindl.) Szlach. | KSD249 | CR | H |
| 32 | *Oberonia* sp.  |  |  | H |
| 33 | *Oberonia falcata* King & Pantl.  | KSD280 | TH | H |
| 34 | *Oreorchis micrantha* Lindl. | KSD289 | CR | H |
| 35 | *Platanthera* sp. | KSD298 |  | H |
| 36 | *Pleione humilis* (Sm.) D. Don | KSD584 | CR | H |
| 37 | *Satyrium nepalense* D. Don  | KSD218 | CR | H |
| 38 | *Dactylorhiza hatagirea* (D. Don) Soó | KSD58 | CR | H |
| 39 | *Dendrobium amoenum* Wall. ex Lindl. | KSD219 | CR | H |
| 40 | Poaceae | *Agrostis micrantha* Steud. | KSD231 | TH | H |
| 41 | *Bromus himalaicus* Stapf | KSD232 | TH | H |
| 42 | *Chrysopogon gryllus* (L.) Trin. | KSD510 | HE | H |
| 43 | *Cyrtococcum patens* var. *latifolium* (Honda) Ohwi | KSD234 | TH | H |
| 44 | *Festuca* sp.  | KSD235 |  | H |
| 45 | *Isachne albens* Trin. | KSD236 | TH | H |
| 46 | *Poa infirma* Kunth |  | TH | H |
| 47 | *Setaria plicata* (Lam.) T. Cooke | KSD237 | TH | H |
| 48 | *Themeda arundinacea* (Roxb.) A.Camus | KSD244 | TH | H |
| 49 | *Trisetum spicatum* (L.) K.Richt. | KSD555 | TH | H |
| 50 | *Cynodon dactylon* (L.) Pers. |  | HE | H |
| 51 | *Dendrocalamus hamiltonii* Nees & Arn. Munro  |  | CR | H |
| 52 | *Thysanolaena latifolia* (Roxb.) Kuntze |  | CH  | H |
| 53 | *Thamnocalamus spathiflorus* (Trin.) Munro  |  | CH | H |
| 54 | *Himalayacalamus brevinodus* Stapleton |  | CH | H |
| 55 | *Eulaliopsis binata* (Retz.) C.E. Hubb. | KSD247 | HE | H |
| 56 | *Imperata cylindrica* (L.) P. Beauv. | KSD248 | HE | H |
| 57 | Smilacaceae | *Smilax aspera* L. | KSD27 | CR | C  |
| 58 | *Smilax menispermoidea* A. DC. | KSD241 | CR | C  |
| 59 | Zingiberaceae | *Hedychium spicatum* Sm.  |  KSD238 | CR | H |

**Table 3:** List of gymnosperms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N.** | **Family** | **Scientific Name** | **Collection Number** | **Life Forms** | **Habits** |
| 1 | Taxaceae | *Taxus wallichiana* Zucc. | KSD18 | PH | T |
| 2 | Pinaceae  | *Pinus wallichiana* A.B. Jacks  | KSD202 | PH | T |
| 3 | *Abies* sp. |  | PH | T |
| 4 | Cupressaceae | *Juniperus squamata* Buch.-Ham. ex D. Don | KSD29 | PH | T |
| 5 | *Juniperus recurva* Buch.-Ham. ex D. Don |  KSD206 | PH | T |

**Table 4:** List of pteridophytes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N.** | **Family** | **Scientific Name** | **Collection Number** | **Life Forms** | **Habits** |
| 1 | Athyriaceae | *Diplazium esculentum* (Retz.) Sw. | KSD610 | CH  | H |
| 2 | Cyatheaceae | *Alsophila spinulosa* (Wall. ex Hook.) R. M. Tryon |  | PH | T |
| 3 | Dennstaedtiaceae | *Pteridium revolutum* (Bl.) Nakai | KSD612 | HE | H |
| 4 | *Dennstaedtia appendiculata* (Wall. ex Hook.) J. Sm. | KSD614 | CH | H |
| 5 | Dryopteridaceae | *Dryopteris barbigera* (Hook.) O. Kuntze | KSD553 | HE | H |
| 6 | *Polystichum* sp.  | KSD604 | HE | H |
| 7 | Equisetaceae | *Equisetum arvense* L. | KSD615 | CR | H |
| 8 | Gleicheniaceae | *Dicranopteris linearis* (Brum.fil.) Underw. | KSD609 | HE | H |
| 9 | *Diplopterygium giganteum* (Wall. ex Hook.) Nakai | KSD607 | HE | H |
| 10 | Lycopodiaceae | *Palhinhaea cernua* (L.) Carv. Vasc. & Franco | KSD619 | CH | C |
| 11 | *Phlegmariurus pulcherrimus* (Hook. & Grev.) Löve & Löve | KSD620 | CH | H |
| 12 | *Lycopodium clavatum* L. | KSD558 | CH | H |
| 13 | Nephrolepidaceae | *Nephrolepis cordifolia* (L.) Presl | KSD625 | CR | H |
| 14 | Oleandraceae | *Oleandra wallichii* (Hook.) Presl | KSD623 | CR | H |
| 15 | Ophioglossaceae | *Ophioglossum reticulatum* L.  |  | TH | H |
| 16 | *Japanobotrychum lanuginosum* (Wall. ex Hook. & Grev.) M. Nishida ex Tagawa | KSD621 | CR | H |
| 17 | Polypodiaceae | *Pyrrosia flocculosa* (D. Don) Ching | KSD635 | CH | H |
| 18 | *Lepisorus nudus* (Hooker) Ching | KSD634 | CH | H |
| 19 | Pteridaceae | *Haplopteris taeniophylla* (Copel.) E. H. Crane | KSD630 | CH | H |
| 20 | *Onychium siliculosum* (Desv.) C. Chr.  | KSD631 | CH | H |
| 21 | *Pteris aspericaulis* Wall. ex Ag.  | KSD632 | HE | H |
| 22 | *Aleuritopteris rufa* (D.Don) Ching | KSD627 | HE | H |
| 23 | *Pteris* sp.  | KSD626 | HE | H |
| 24 | Selaginellaceae | *Selaginella* sp.  | KSD628 | HE | H |
| 25 | Tectariaceae | *Tectaria coadunata* (J. Smith) C. Christensen |   | HE | H |

Life Froms: PH-Phanerophytes, CH-Chamaephytes, HE-Hemicryptophytes, TH-Therophytes, CR-Cryptophytes, P-Parasite

Habits: C-Climber, H-Herb, S-Shrub, T-Tree

**Table 5:** Raunkier classification description

|  |  |  |
| --- | --- | --- |
| **S.N.** | **Life Form** | **Description** |
| 1 | Chamaephytes | Species with perenating buds born on aerial parts but close to the ground (no more than 25 cm above the soil surface). |
| 2 | Cryptophytes (Geophytes) | Plant species with buds or shoot apices which survive the unfavorable period below ground or water (species with rhizome, bulb or tuber).  |
| 3 | Hemicryptophytes | All above ground parts of the plant die back in unfavorable conditions and buds are born at ground surface. |
| 4 | Phanerophytes | Woody species with perenating buds emerging from aerial parts.  |
| 5 | Therophytes | Plant species survive unfavorable condition as seeds (annuals). |

**Table 6:** Prioritized species by different organizations

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.N.** | **Scientific Name** | **CAMP** | **CITES** | **IUCN** | **GON/Government Activity** |
| 1 | *Taxus wallichiana* Zucc. | Endangered | II | Endangered | 2 |
| 2 | *Dolomiaea macrocephala* Royle | Near Threatened |  |  |  |
| 3 | *Maharanga emodi* (Wall.) A. DC. | Data Deficit |  |  |  |
| 4 | *Maharanga bicolor* (Wall.ex G. Don) A. DC. | Data Deficit |  |  |  |
| 5 | *Nardostachys jatamansi* (D. Don) DC. | Vulnerable | II | Critically Endangered | 2/ Medicinal Plants for research and development |
| 6 | *Swertia angustifolia* Buch.-Ham. ex D. Don  | Endangered |  |  |  |
| 7 | *Swertia chirayta* (Roxb.) Karst. | Vulnerable |  |  | Medicinal Plants for research and development |
| 8 | *Paris polyphylla* Sm | Vulnerable |  |  | Medicinal Plants for research and development |
| 9 | *Picrorhiza scrophulariiflora* (Pennell) D.Y. Hong | Vulnerable |  |  | 3/ Medicinal Plants for research and development |
| 10 | *Rheum australe* D. Don | Vulnerable |  |  | Medicinal Plants for research and development |
| 11 | *Aconitum spicatum* (Brühl) Stapf | Vulnerable |  |  | Medicinal Plants for research and development |
| 12 | *Rubia manjith* Roxb. | Vulnerable |  |  | Medicinal Plants for research and development |
| 13 | *Arisaema costatum* (Wall.) Mart | Least Concern  |  |  |  |
| 14 | *Asparagus racemosus* Willd. | Vulnerable |  |  | Medicinal Plants for research and development |
| 15 | *Fritillaria cirrhosa* D. Don | Vulnerable |  |  |  |
| 16 | *Dactylorhiza hatagirea* (D. Don) Soó | Endangered | II |  | 1/ Medicinal Plants for research and development |
| 17 | *Dioscorea deltoidea* Wall. ex Griseb. | Endangered | II |  |  |
| 18 | *Alsophila spinulosa* (Wall. ex Hook.) R. M. Tryon |  | II |  |  |
| 19 | *Zanthoxylum armatum* DC |  |  |  | Medicinal Plants for research and development |
| 20 | *Juglans regia* L. (Barks) |  |  |  | 1 |

GoN: Government of Nepal 1= Complete ban: Ban for collection, use, trade, transportation and export, 2= Ban raw export: Banned for export outside the country without processing, 3= Conditional harvesting: The wild harvest and sale allowed only after the taxonomic identification and confirmation of the species as *Picrorhiza scrophulariiflora* Pennellby DPR, and then the final approval of DFO after its inventory and identification of its total natural and harvestable stock in the wild

IUCN: International Union for Nature Conservation

CAMP: Conservation Assessment and Management Plan

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora