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Cover: A female Javan Leopard *Panthera pardus melas* in rehabilitation phase at Cikananga Wildlife Center. © Yayasan Cikananga Konservasi Terpadu.



## A case study on utilization and conservation of threatened plants in Sechu Tuan Nalla Wildlife Sanctuary, western Himalaya, India

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**Abstract:** During the course of surveys between 2016 and 2019 in the Sechu Tuan Nalla Wildlife Sanctuary, 37 species were reported of which, two critically endangered, 18 endangered, 13 vulnerable, four data deficient and one endemic to western Himalayas were recorded. All the species recorded are highly priced medicinal herbs. It also discussed the sustainable use and conservational approach adopted by the local people dwelling in the vicinity of the protected area for an endangered medicinal plant, *Fritillaria cirrhosa* D. Don.

**Keywords:** Endangered, endemic, *Fritillaria cirrhosa*, high altitude, Jangli lahsun, Pangri Valley, medicinal plants.

**Abbreviations:** STNWS—Sechu Tuan Nalla Wildlife Sanctuary | WS—Wildlife Sanctuary | GOI—Government of India | BSD—Herbarium of Botanical Survey of India, Northern Regional Centre, Dehradun | IUCN—International Union for Conservation of Nature | CAMP—Conservation Assessment and Management Prioritization | CITES—Convention on International Trade in Endangered species of Fauna and Flora | RDBIP—Red Data Book of Indian Plants | UT—Union territory.

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**Author contributions:** PK and HS did the field surveys and collection as well as drafting of the article. SKS help in making the article.

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## INTRODUCTION

The biodiversity is deteriorating at faster rate and ecosystem services are greatly affected and are among one of the major issues encountered by humanity today (Piccolo 2017). Protected areas form the basis of biodiversity conservation worldwide and play a vital role in the rehabilitation of deteriorated natural habitat (Margules & Pressey 2000; Mashizi & Sharafatmandrad 2020). Assessment of threatened plant diversity of protected areas is essential for the protection and appropriate management of biodiversity. The study of protected areas offers plenty of scope for framing suitable management policies. These areas are important for the collection and documentation of scientific data on bio-resources which provide gateways for sustainable use and conservation. Several protected areas including national parks and wildlife sanctuaries have been evaluated for endemic and threatened plants throughout the country.

In this paper, we aim to highlight the sustainable approach towards the conservation and use of *Fritillaria cirrhosa* D. Don. (syn. *Fritillaria roylei* Hook.) by the people in and around the WS. *F. cirrhosa* D. Don is a threatened medicinal herb, flourishing well in high-altitude areas on grassy slopes (Image 2a–e) of western Himalaya of India (Jammu & Kashmir UT, Ladakh UT, Himachal Pradesh, and Uttarakhand), Afghanistan, and Pakistan. Local people of Pangli valley call it 'Jangli lahsun' otherwise known as 'Kakoli' in other parts of the Himalayan region. Bulbs of this Himalayan medicinal herb has an international market and are highly priced (INR 8,000–20,000 /kg). Bulbs are chiefly used in traditional Ayurvedic and Chinese medicine system. The plant flourishes in the upper reaches of the two forest beats (Tuan and Sechu) of the WS. The bulbs are beneficial in the cure of rheumatism, cough, fever and many other ailments (Kirtikar & Basu 1984). The species is prized for its immense medicinal properties and constitutes an important part of many herbal formulations (e.g., Astavarga, Chyavanprash). The tribal populace harvests the plant from the wild and sell it to the buyers sometimes directly or at times through middlemen. These middlemen are either agents of pharmaceutical or ayurvedic companies or of wholesale raw material suppliers that connect the distant farmer to the buyer. As a result of its relentless exploitation from the wild, this medicinal herb has become endangered in the Indian Himalayan region. The population status of the medicinally important species has deteriorated to the extent that it has now been considered endangered in Western Himalaya (IUCN 2001; Kuniyal et al. 2015). There is an urgent need to address the declining population of

this species and to take initiative for suitable conservation strategies along with sustainable utilization.

The distribution of published information on the conservation status of plants can be effective to increase the level of awareness among stakeholders. Therefore, in the present communication, we also aimed to bring a list of the number of threatened plants which are growing in wild in the wildlife sanctuary. This study also highlights some of the threatened plants grown by local people and forest department officials. Some gap areas and recommendations are also provided in the paper.

## MATERIALS AND METHODS

### Study area

Sechu Tuan Nalla Wildlife Sanctuary is a remote WS in the interior Himalaya in the Pangli tehsil of Chamba district of Himachal Pradesh, India (Image. 1). It is home to many rare, endemic and threatened species of flora and fauna (GOI 2016). The WS was established in 1974 with a purpose of conservation of Brown Bear and Snow Leopard. However, it has also conserved over the years the rich floral wealth of the region. The flora is distinct with floral elements from temperate to alpine to cold desert biome. Several endemic and threatened plant species thrive and flourish in the region. This is due to the sustainable approach followed by the people inhabiting the eco-sensitive zone of WS, i.e., the *Pangwals* and the *Bhots* tribal communities. The sanctuary is in a very remote region with adverse climatic conditions and no proper road or telecom connectivity. People dwelling in these regions have no other option for their economic upsurge other than to market the local natural resources available. With the trending use of Ayurveda and traditional system of medicines in the modern-day world, there has been a gradual increase in demand of plant based Ayurvedic and medicinal products. The region being rich in medicinal plants especially highly priced Himalayan herbs is emerging as a supplier of raw materials.

### Plant explorations and identification

Plant specimens were collected in the study site using a random sampling approach. Information on the uses of plants was collected from the local people inhabiting in the vicinity of the wildlife sanctuary. Informants comprised of 15 people from each village including elderly and younger ones. Local people were interviewed for the uses, cultivation practices and any potential threat to these species according to their perception.

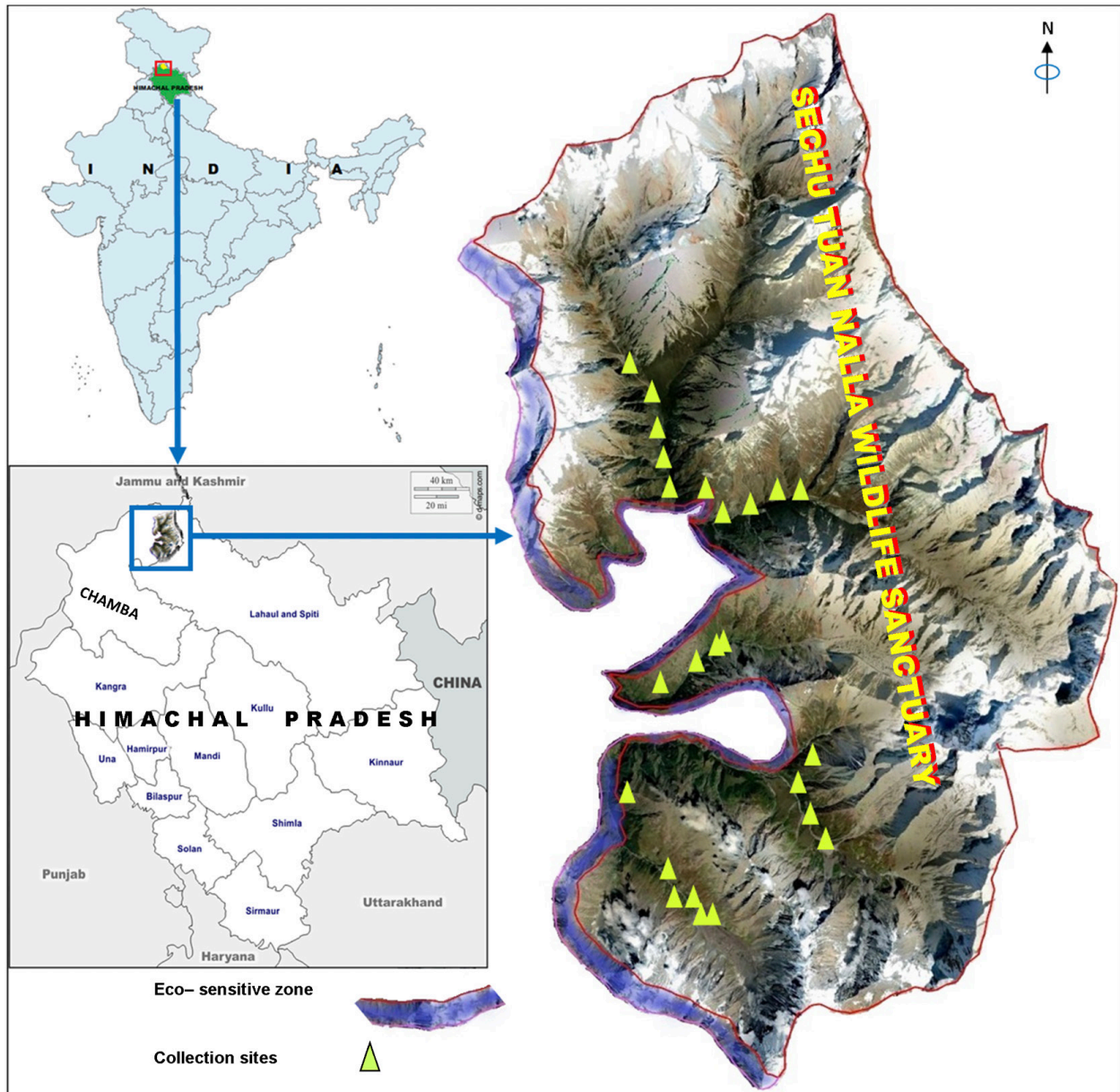


Image 1. Map of study area with collection sites in Sechu Tuan Nalla Wildlife Sanctuary in Chamba district, Himachal Pradesh, India.

The collected plant specimens were identified with the help of the herbarium (BSD) of Botanical Survey of India, Northern Regional Centre, Dehradun, Uttarakhand, India and other regional floras. Conservation status given in table 1 is as per Red List of plants in International Union for Conservation of Nature and Natural Resources (IUCN 2001), Conservation Assessment and Management Prioritisation (Ved et al. 2003), Convention on International Trade in Endangered (CITES, [http://www.bsienviis.nic.in/Database/bsi\\_3949.aspx](http://www.bsienviis.nic.in/Database/bsi_3949.aspx)), Red Data Book of Indian Plants (Jain & Sastry 1980, 1984; Nayar & Sastry 1987, 1988, 1990; Rao et al. 2003) and recent literature

(Rawat 2005; Rana & Samant 2010) on assessment of these plants in western Himalaya by various active and prominent researchers.

## RESULTS

Overall, 37 threatened and endemic plant species (Table 1, image 3a–f) were found in the sanctuary and its environs. A total of two species, *Lilium polyphyllum* D. Don and *Saussurea costus* (Falc.) Lipsch. or 5.40% of taxa assessed were listed as Critically Endangered (CR) (Figure



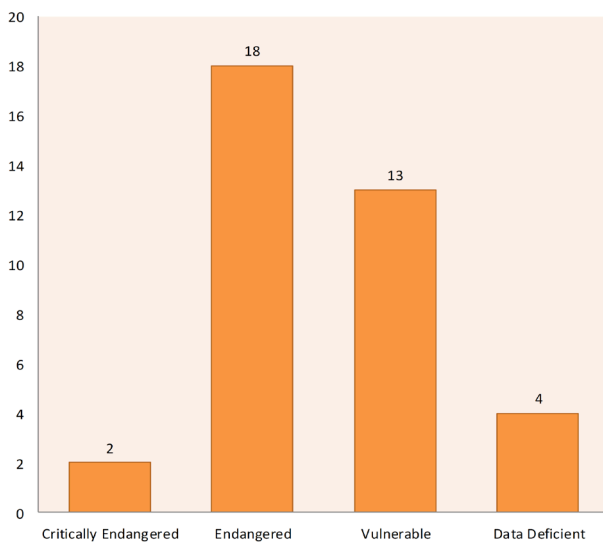


Figure 1. Number of species in various threat categories.

1). In the meantime, 18 (48.65%) of taxa were classified as Endangered (EN) and 13 (35.14%) were classified as Vulnerable (VU). Another four (10.81%) were listed as Data Deficient (DD) which means that there is inadequate data for appropriate assessment of conservation status to be prepared. As far as the frequency of occurrence in the study is concerned, out of 37 species, 28 (75.68 %) are infrequent while nine (24.32 %) are scarce in the study area.

## DISCUSSION

Local people of Pangi valley call it Jangli lahsun otherwise known as kakoli in other parts of Himalayan region.

'Praja', the local indigenous governing body plays a major role in managing the local resources of the area. The Praja is a local institution comprising of at least a single member of every household in the village and acts as an administrative and social reforming body. The Praja appoints people of the village to keep an eye on any kind of illegal activity by outsiders that may destroy the plants in the wild. People or other tourists need to get themselves registered or to provide prior information at the village before entering the adjoining forest during the harvest season.

The systematic and phase-wise collection of bulbs of Jangli lahsun from the wild is allowed to only the inhabitants of hilly regions of the state (Badola & Butola 2004). However, no one can harvest the plant before the seed is set and dispersed; ensuring sufficient

seed is available for germination for the next year. While collecting the bulb of the plant care is taken not to disturb the adjoining vegetation. Such simple yet powerful efforts by the locals have led to a very healthy population of the species in Tuan Forest beat of the WS. Therefore, these traditional practices keep a check on illegal means of exploitation of this plant species and have positive effects on its conservation. On the contrary, Sindhani Dhar, an inaccessible region of the WS from the Sechu beat was once home to a very healthy population of Jangli lahsun, which over the span of 4–5 years was ruined by outsiders from the adjoining regions. The plant was so badly exploited in the Sindhani region that the population once in thousands came to a scattered few plants. Habitat degradation has also led to substantial pressure on the wild population of *F. cirrhosa* in many parts of western Himalaya. The population of the species in the western Himalaya has declined to an alarming situation (Chauhan et al. 2011). This decline is attributed to the uprooting of the whole individual at early growth stages before the seed sets. Bisht et al. (2016) cited some other factors such as early snowfall and frequent grazing by migratory animals in alpine meadows which affected the regeneration of the species. The species population has declined to the level that it has been put into the endangered category in western Himalaya (IUCN 2001; Kumar et al. 2011; Kuniyal et al. 2015; Bisht et al. 2016). All the species of an ecosystem are important and equally contribute to stabilizing a particular ecosystem, and loss of a single species can have grave consequences. Therefore, regardless of medicinal or any other importance, all the species should be treated important for the preservation of biodiversity.

### Positive approach through sustainable utilization coupled with conservation efforts

The traditional practices to keep check on illegal means of exploitation of this plant species have positive effects on its conservation. Probably the lacuna is that there is no such effective and efficient management plan existing in the area for cultivation of most other medicinal endangered plant species except for few. *Dioscorea deltoidea* Wall. ex Kunth, *Picrorhiza kurroa* Royle ex Benth., *Sinopodophyllum hexandrum* (Royle) T.S.Ying, *Saussurea costus* (Falc.) Lipsch. are being cultivated in the forest nurseries (Image 4). Both the extraction of the medicinal plants for household purpose by the local people and illegal destructive harvesting by outsiders is mainly from wild populations. As the socio-economic condition of the local inhabitants depends upon the natural resources available, cultivation of medicinal

Table 1. Endemic and threatened species from Sechu Tuan Nalla Wildlife Sanctuary.

Name of species	Local name (if any)	Family	Habit	Locality with altitude	Collection no.	Conser- vation Status as per IUCN, CAMP, RDBIP& Regional Publica- tions	Occurrence in study area	Cause
1. <i>Acer caesium</i> Wall. ex Brandis		Aceraceae	Tree	Saichu Dhar, 2,888 m	Puneet Kumar 127737 (BSD)	VU	Scarce	Exploitation in the past for timber.
2. <i>Aconitum violaceum</i> Jacquem. ex Stapf		Ranunculaceae	Herb	Chasak Bhattori to Sechu, 3,696 m	Puneet Kumar 127624 (BSD)	VU	Infrequent	Over exploitation of medicinal roots.
3. <i>Aconitum heterophyllum</i> Wall. ex Royle	Atish	Ranunculaceae	Herb	Along Sindhmarh Nalla, 3,592 m	Puneet Kumar 127609 (BSD)	EN	Infrequent	Over exploitation of medicinal roots.
4. <i>Allium stracheyi</i> Baker	Jambu	Alliaceae	Herb	Eco-sensitive zone around Hillu-Tuan, 3,272 m	Puneet Kumar 128034 (BSD)	VU	Scarce	Exploitation of corms.
5. <i>Angelica glauca</i> Edgew.	Chura	Apiaceae	Herb	Eco-sensitive zone (on way to Chasak Bhatoni), 3,453 m	Puneet Kumar 132603 (BSD)	EN	Infrequent	Over exploitation of medicinal rhizomes.
6. <i>Aralia cachemirica</i> Deane.		Araliaceae	Herb	Harbi Dhar, 3,457 m	Puneet Kumar 127305 (BSD)	VU	Scarce	Very few individuals. Endemic to NW Himalaya.
7. <i>Arenaria neelgherensis</i> Wight & Arn.		Caryophyllaceae	Herb	Pepe Nalla, Chasakh Bhattori, 3,988 m	Puneet Kumar 127451 (BSD)	DD	Scarce	Very few individuals.
8. <i>Berberis pseudoambellata</i> R. Parker	Kiamal	Berberidaceae	Shrub	Harbi Dhar, 3,128 m	Puneet Kumar 127817 (BSD)	DD	Infrequent	Exploited for medicinal uses.
9. <i>Bergenia ciliata</i> (Haw.) Sternb.	Shapdochi	Saxifragaceae	Herb	On way to Sidhani Dhar 2,712 m	Puneet Kumar 127961 (BSD)	VU	Infrequent	Exploitation of medicinal rhizomes.
10. <i>Bergenia stracheyi</i> (Hook.f. & Thomson) Engl.	Shapdochi	Saxifragaceae	Herb	Along Triund Nalha towards Chogalu Dhar, 3,551 m	Puneet Kumar 132519 (BSD)	VU	Infrequent	Exploitation of medicinal rhizomes.
11. <i>Bunium persicum</i> (Boiss.) B. Fedtsch.	Kala Zeera	Apiaceae	Herb	Eco-sensitive zone, Mujh village, 3,121 m	Puneet Kumar 128032 (BSD)	EN	Infrequent	Exploitation directly from wild, whole plant uprooted for seeds.
12. <i>Corallorhiza trifida</i> Châtel.		Orchidaceae	Herb	Sidhani Dhar, 3,469 m	Puneet Kumar 132562 (BSD)	EN, CITES Appendix II	Infrequent	Limited distribution with few individuals (single locality in study area) in Western Himalaya.
13. <i>Dactylorhiza hatagirea</i> (D. Don) Soo	Hathpanja or Salam Panja	Orchidaceae	Herb	Eco-sensitive zone near Sindhari, 3,544 m	Puneet Kumar 127643 (BSD)	EN, CITES Appendix II	Scarce	Over exploitation of medicinal root-tubers.
14. <i>Dioscorea deltoidea</i> Wall. ex Kunth		Dioscoreaceae	Climber	Harbi Dhar, 3,350 m	Puneet Kumar 127309 (BSD)	EN, CITES Appendix II and Negative List of Exports	Infrequent	Decline in population owing to over exploitation of medicinal/edible rhizome. Tough to cultivate commercially due to its very slow growth.
15. <i>Epipactis helleborine</i> (L.) Crantz		Orchidaceae	Herb	Sidhani Dhar, 2,879 m	Puneet Kumar 132591 (BSD)	VU, CITES Appendix II	Infrequent	With very few individual and habitat specific.



Name of species	Local name (if any)	Family	Habit	Locality with altitude	Collection no.	Conservation Status as per IUCN, CAMP, RDBIP & Regional Publications	Occurrence in study area	Cause
16. <i>Eremurus himalaicus</i> Baker	Piyau	Asphodelaceae	Herb	Sidhani Dhar, 2,931 m	Puneet Kumar 128011 (BSD)	EN, Endemic to Western Himalaya.	Infrequent	Exploited for edible foliage roots.
17. <i>Ferula jaeschkeana</i> Vatke	Kurash	Apiaceae	Herb	Along Triund Nalha, 3,207 m	Puneet Kumar 127872 (BSD)	EN	Infrequent	Exploited for medicinal uses.
18. <i>Fritillaria cirrhosa</i> D. Don	Jangli Lahsun	Liliaceae	Herb	Along Triund Nalha towards Chogalu Dhar, 3,503 m	Puneet Kumar 128149 (BSD)	EN	Infrequent	Ashtavarga herb, Bulbs (medicinal) are sold at very high prices Rs. 4000-5000/kg. Extracted from wild and no cultivation.
19. <i>Gymnadenia orchidis</i> Lindl.		Orchidaceae	Herb	Sidhani Dhar, 3,625 m	Puneet Kumar 132561 (BSD)	EN, CITES Appendix II	Infrequent	With very few individuals in study area.
20. <i>Hedysarum astragaloides</i> Benth. ex Baker		Fabaceae	Herb	Pepe Nalla, Chasakh Bhatari, 3,826 m	Puneet Kumar 127422 (BSD)	DD	Infrequent	With very few individuals in study area.
21. <i>Hedysarum microcalyx</i> Baker		Fabaceae	Herb	Towards North of Bhatari Seri along Sindhmarrh Nalla, 3,693 m	Puneet Kumar 127557 (BSD)	Vulnerable	Scarce	With very few individuals in study area.
22. <i>Hyoscyamus niger</i> L.	Khurasani Ajwain	Solanaceae	Herb	Saichu Dhar, 2,868 m	Puneet Kumar 127755 (BSD)	VU	Infrequent	Over exploitation of medicinal.
23. <i>Dolomiaea macrocephala</i> DC.	Dhoop	Asteraceae	Herb	Along Sindhmarrh Nalla, 3,294 m	Puneet Kumar 127602 (BSD)	EN	Infrequent	With very few individuals in study area. Exploitation of aromatic and medicinal rhizome.
24. <i>Lilium polyphyllum</i> D. Don	Ksheerkakoli	Liliaceae	Herb	Along Sindhmarrh Nalla, 3,405 m	Puneet Kumar 127594 (BSD)	CR	Infrequent	Ayurvedic herb. Harvested for its bulbs. A whole plant is uprooted and disturbed. Of its total Geographical distribution in Himalayan region, 80% is in India.
25. <i>Malaxis muscifera</i> (Lindl.) Kuntze	Rshbhak	Orchidaceae	Herb	Towards north of Bhatari Seri along Sindhmarrh Nalla, 3,595 m	Puneet Kumar 127549 (BSD)	EN, CITES Appendix II	Infrequent	Ashtavarga herb. Corms medicinal.
26. <i>Mecanopsis aculeata</i> Royle	Veerbhuti	Papaveraceae	Herb	Pepe Nalla, Chasakh Bhatari, 3,740 m	Puneet Kumar 127468 (BSD)	EN	Scarce	Exploited for medicinal uses. Habitat destruction.
27. <i>Picrorhiza kurroa</i> Royle ex Benth.	Kour	Plantaginaceae	Herb	Sidhani Dhar, 3,670 m	Puneet Kumar 132569 (BSD)	EN, CITES Appendix II and Negative List of Exports	Infrequent	Over exploitation of medicinal rhizomes.



Name of species	Local name (if any)	Family	Habit	Locality with altitude	Collection no.	Conservation Status as per IUCN, CAMP, RDBIP & Regional Publications	Occurrence in study area	Cause
28. <i>Sinopodophyllum hexandrum</i> (Royle) T.S. Ying	Bankakri	Berberidaceae	Herb	Along Jambu Nalla towards Ghatnar, 3,302 m	Puneet Kumar 127258 (BSD)	EN, CITES Appendix II and Negative List of Exports	Infrequent	Over exploitation from wild for its medicinal value.
29. <i>Polygonatum cirrhifolium</i> (Wall.) Royle	Salam mishri	Convallariaceae	Herb	Sidhani Dhar, 2,716 m	Puneet Kumar 132577 (BSD)	VU	Infrequent	Ashtavarga herb Rhizomatous rootstock medicinal.
30. <i>Polygonatum verticillatum</i> (L.) All.	Salam mishri	Convallariaceae	Herb	Along Triund Nalla towards Chogalu Dhar, 3,504 m	Puneet Kumar 132510 (BSD)	VU	Infrequent	Ashtavarga herb Rhizomatous rootstock medicinal.
31. <i>Rheum spiciforme</i> Royle	Chukri or Revand chini	Polygonaceae	Herb	Sidhani Dhar, 3,177 m	Puneet Kumar 132599 (BSD)	VU	Scarce	Exploitation of medicinal rootstock.
32. <i>Rheum webbianum</i> Royle	Chukri or Revand chini	Polygonaceae	Herb	Pepe Nalla, Chasakh Bhatari, 3779 m	Puneet Kumar 127455 (BSD)	VU	Infrequent	Exploitation of medicinal rootstock.
33. <i>Saussurea costus</i> (Falc.) Lipsch.	Kuth	Asteraceae	Herb	Towards North of Bhatari Seri along Sindhmarh Malla, 3,677 m	Puneet Kumar 127501 (BSD)	CR, CITES Appendix I and Negative List of Exports	Infrequent	Indiscriminate collection (for its roots) and destruction of habitat. Few individuals in cultivation in the vicinity of villages.
34. <i>Saussurea roylei</i> (DC.) Sch. Bip.		Asteraceae	Herb	Sidhani Dhar, 3,959 m	Puneet Kumar 132553 (BSD)	DD	Infrequent	Whole plant is exploited for medicinal uses.
35. <i>Taxus wallichiana</i> Zucc.	Rakhal	Taxaceae	Tree	On way to Sidhani Dhar, 2,879 m	Puneet Kumar 132587 (BSD)	EN, CITES Appendix II and Negative List of Exports	Infrequent	Over exploitation of medicinal bark.
36. <i>Trillium govatanum</i> Wall. ex D. Don	Nag Chhatri	Trilliaceae	Herb	Sidhani Dhar, 3,240 m	Puneet Kumar 132532 (BSD)	EN	Scarce	Exploited for medicinal uses.
37. <i>Trollius acaulis</i> Lindl.		Ranunculaceae	Herb	Seen on way to Sidhani Dhar, 3,176 m		EN	Infrequent	Only three individuals seen in single locality near glacier.

CR—Critically Endangered | EN—Endangered | VU—Vulnerable | DD—Data Deficient | BSD—Herbarium of Botanical Survey of India, Northern Regional Centre Dehradun.

Note: Due to sensitivity of critically endangered species we are not giving geo-coordinates here in this communication however, in case anybody required data for genuine research purpose can get information by contacting the corresponding author.



Image 2 (a–e). a—*Fritillaria cirrhosa* D. Don., growing in its natural habitat on alpine grassy slopes, single flower in inset | b—Three terminal solitary drooping flower's top view | c—Inverted flower view to show stigma and anthers | d—Upright maturing capsules coming out of the withering floral parts | e—Bulb (arrowed), along with two uprooted young plants. © Puneet Kumar.





Image 3. (a-f) Threatened plants. a—*Dactylorhiza hatagirea* (D. Don) Soó | b—*Trillium govanianum* Wall. ex D. Don | c—*Lilium polyphyllum* D. Don | d—*Saussurea costus* (Falc.) Lipsch. | e—*Sinopodophyllum hexandrum* (Royle) T.S. Ying | f—*Picrorhiza kurroa* Royle ex Benth. © Puneet Kumar.

and aromatic plants should be encouraged among the farmers for their betterment. Though the local people have shown interest in the cultivation of these medicinal plants, the efforts turn out to be futile probably due

to unscientific cultivation practices. The scientific community should come forward to help in improving the methods of cultivation presently employed by these farmers. Although many of the important medicinally



**Image 4. A forest nursery in the vicinity of study area. © Harminder Singh.**

threatened plants still need more research to bring them successfully to the farmer's field for cultivation, priority should be given to the restoration and rehabilitation of these medicinal plants in their natural habitat. Otherwise, direct extraction from wild resources may result in the vanishing of these important medicinal plants from this remote area of western Himalaya.

These plants are used by the locals in a sustainable way and not harvested before seed is set. The plants are left untouched when local tribes collect fodder for winter stock. As a result, majority of the populations of these medicinal plants are flourishing well near the villages in the vicinity of eco-sensitive zone of the sanctuary. Furthermore, it is suggested local nurseries should be strengthened with recent cultivation techniques of plants of high altitudes and also local people should be made aware of the natural resources around them by conducting awareness programs and workshops. Increasing awareness on the part of people can improve the possibility of endurance of rare, endemic, threatened, and medicinal plant species.

## CONCLUSION

The study highlighted the sustainable approach of local people towards the use of resources around the WS. Local people and their efforts are the very essence that has conserved the floral heritage of the Great Himalaya over the centuries. Linking local communities to conservation programs for natural resources and management of forests can be the way forward to biodiversity protection and sustainable development. The study highlighted the sustainable approach of local people towards the use of resources around the WS.

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