

Community-based Biodiversity Conservation in the Himalayas

Editors
Yogesh Gokhale and Ajeet K Negi



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Foreword

Nestled among the mighty Himalayas, the state of Uttarakhand represents a unique mix of biological and cultural heritage. The state is known for its rich tradition of community-based conservation in the face of increasing demands for industrialization.

India's legislative framework, which had for long turned a blind eye on these traditions, is beginning to concede the importance of community institutions as an important vehicle for conservation. Significantly, the Biological Diversity Act, 2002, mandates the formation of local-level biodiversity management committees and recognizes the need to identify sites of biodiversity importance as heritage sites, marking a departure from the state-led command-and-control approaches towards conservation. In this scenario, it is critically important to document community efforts in managing biological resources, especially in states like Uttarakhand, where these resources constitute a global public good with enormous local benefits.

This volume brings together a set of articles that explore the participatory resource management systems and institutions such as van panchayats and sacred groves, and attempts to assess their compatibility with current legislative and policy provisions. In a significant way, these articles aim at bridging the gap between policy and practice, to provide field-level inputs to national- and state-level processes of policy deliberation. Several of these articles were presented in a state-level workshop on community conservation in biodiversity-rich areas (Srinagar, Garhwal, 24–25 November 2009) and received critical inputs from a cross-section of experts and stakeholders.

I would strongly recommend this volume to all practitioners of natural resource management and anyone interested in delving into our deep cultural traditions.



R K Pachauri, PhD
Director-General, TERI

Preface

Traditional methodologies and conservation in the Uttarakhand Himalayan region

INTRODUCTION

Since time immemorial, mountain dwellers and tribal people follow a tradition of judicious utilization of their natural resources. Over the centuries, a symbiotic relationship developed and a methodology evolved for harmonious coexistence with nature. Irrespective of the fact that the vast and diverse Himalayan terrain is inhabited by multilingual and multiracial people, the people have a common heritage and are dependent on natural resources. These societies had patience, commitments, and appreciation for the values that made them a self-sustaining society.

However, in the last couple of decades, due to industrialization and commercialization, natural resources have become a means of economical development and have opened numerous ways for commercial exploitation. This has caused rapid depletion of these resources, thus depriving the mountain societies of their livelihood support base. On one hand, this sort of indiscriminate exploitation of natural resources provided many opportunities to industrialists and capitalists to further augment their profit, while on the other hand, this limited the vital resource base for the sustenance of the mountain dwellers. Today, the situation has worsened to the extent that majority of the marginal communities have been forced to face several hardships to earn their livelihood.

The vividness of the mighty Himalayan range is due to its extreme geomorphological setting, encompassing altitudes ranging from a few metres to thousands of metres. Where the warm fertile plains surround it in the south, the Trans-Himalayan ranges in the north are the abode of perpetual snow cover and glaciers. The geographical vividness of the terrain paved the way for rich biodiversity. This is adequately demonstrated by the minor and major forest assemblages, ranging from the rich deciduous forest in the foothills grading into the fir-spruce in higher altitudes. Similar is the case with the fauna. The foothills are rich habitats for rhinoceros and elephants, whereas, the endangered snow leopards reside in the higher reaches. In the same way, people could adapt to a lifestyle according to the terrain boundary condition in which the major source of livelihood was nature and natural resources. Where nature is the main source of survival, it is likely that the urge towards its conservation becomes

natural instinct. Thus, judicious utilization and maximum conservation of natural resources are inherent characteristic of the people living in the Himalayas.

UTTARAKHAND HIMALAYAS

Although the entire 2500-km-long Himalayan range is important for modulating the climate of the Indian subcontinent, the part of the range in the Uttarakhand region has a unique entity because of the two major rivers—the Ganga and the Yamuna. These two rivers have their source in this region. These rivers are the perennial source of life to the majority of the population in the northern Gangetic plain. Flanked by Nepal and Tibet in the east and north, Himachal Pradesh in the west, and the fertile plains of Uttar Pradesh in the south, the rich forest and water resources of this region make it a prosperous region. Though the terrain is rugged and difficult, people inhabited the region because of the rich forest and its produce. The fertile soil, availability of water, and forest helped the people in this region lead a self-contained life. These resources were under their command; they were the masters of their surrounding—its harvesters, protectors, and promoters. The forests fulfilled more than 60% of their domestic requirements. The remaining 40% was met from other resources.

This period also witnessed tremendous developments in the social, spiritual, and cultural fields. Many spiritual places were created, and progress was made in areas like folk culture, art, literature, and social system. Uttarakhand was considered as the seat of learning in the country. However, during the early nineteenth century, as the colonial rulers took over the terrain, the natural resources managed by the people came under the state's control. This period was the beginning of the erosion of traditional rights and indigenous wisdom of natural resources conservation in the region.

WITHERING AWAY OF THE TRADITIONAL SYSTEM

Ancient writings on socio-economic aspects, culture, and religion in the Uttarakhand region have adequately depicted traditional conservation practices. Due to the age-old religious significance of the terrain, it was traversed by millions of people for pilgrimage. Though there were no written laws for protecting nature, it was through religious practices that the sensitive ecosystem was conserved and upgraded. For example, the high altitude alpine pastures (*Bugiyal* in local parlance) were considered the abode of God in the Uttarakhand Himalayan region; hence, people were forbidden from wearing shoes, plucking unripe flowers, wearing bright colours or colours that run, and making loud noise. According to ecologists and environmental scientists, the alpine zone is one of the most fragile ecosystems in the Himalayan region. The unwritten rules, which have already been mentioned, had a religious overtone nonetheless, but there was a component of protection involved; for example, plucking unripe flowers could

lead to the extinction of rare species, shouting could cause avalanches, bright colours could disturb animal life, and so on. Similarly, saddles above the village forests (*Khals* in local parlance) were used for rainwater harvesting, recharging the village spring, and providing drinking water to the wild and domesticated animals. The trees for fuel and fodder were an integral part of the agricultural system. These trees were grown alongside the fields. Sites close to rivers were not used for constructing houses, and unstable slopes were left untouched. A rotational grazing system was in place to avoid undue pressure on the terrain. There were many such unwritten laws, which were practised through a village community system (Panchayati Raj) and passed from one generation to the other in Uttarakhand. A similar lifestyle pattern was followed by people in other parts of the Himalayan region.

As already mentioned, in the beginning of the nineteenth century, the intervention of the British violated the harmonious relationship of the local people with their surroundings. The process began with the marginalization of the local authority on the Brahm Kamal (*Sasoria ovalata*), a much revered flower of the Himalayas, which was never plucked when unripe; it was dedicated to God in high altitude pastures. In order to generate revenue, commercial exploitation of the forest began in addition to imposition of taxes on the land. This was the beginning of the external interference in the village system, which led to unrest among the local masses and gradual erosion of the biodiversity.

There was a great tradition of the Panchayati Raj system (village self-rule) in India. This system helped people settle disputes on their own within the village through the elected representative, the village panch. Such bodies were held in high esteem and no one challenged their authority. This system also prevailed in Uttarakhand where the panchayat was involved in the conservation of the forest, water resources, and their judicious usage. Colonial rule tampered with this novel system of village-level judiciary by making it dependent on government resources. It has become an instrument of indirect imposition of the government's will on the local people.

The observation made was that depriving the local community from self-governance of their resources has not done any good to the region. The policies were aimed at maximum exploitation of the resources and community. There was a component of conservation; however, it was tuned to their long-term interests, and the exploitative policies on the resources were never critically evaluated. Instead, such policy-makers could create a lobby of people with vested interests that stood and supported the unrealistic and oppressive laws of the government. Furthermore, existing educational institutes, instead of creating youth brigades, which should strengthen the age-old social and cultural values, were moulded to suit government jobs. The Indian Forest Act, 1972, and the forest panchayat rules, instead of protecting the interests of the people and the forest, protected the government's interest, which shattered the social fabric of Uttarakhand.

IMPLICATION ON NATURAL RESOURCES

From 1817 to 1823, the period when encroachment on forests started with the declaration of the forest policy in 1988, government campaigns aimed at encroaching on the traditional rights of the people. During the pre-Independence period, the colonial rulers exploited people, and post-Independence, in the name of development, the government carried forward the same policy. As a result, people gradually became disillusioned with their surrounding resources. The government was only interested in collecting more revenue from the forests; thus, people got disheartened, became less concerned about the conservation aspect, and indulged in maximizing benefits from the existing scenario. This ultimately resulted in people losing interest in the government policies, which led to the erosion of century-old traditional practices.

Even the forest cover started to decline, and the government not only started losing revenue, the incidences of natural calamity became more frequent, fertility of soil dwindled due to enhanced erosion, and fuel, fodder, and other forest produce became elusive for the hill and tribal communities. Frequent floods and irregular monsoons hampered the national food production. These events raised the eyebrows of the people. Concern grew at national level. During the early 1970s, as the world was slowly becoming concerned about the global environment, back in the remote locality of Uttarakhand at Gopeshwar in the Chamoli district of India, a social organization called the Dasholi Gram Swarajya Mandal (DGSM) was spearheading a programme on protection, development, and propagation of natural resources in the region. The DGSM, which was constituted in 1964 with the objective of creating village self-rule by protecting and propagating the natural resource base, had to augment its limited resources after witnessing a major calamity in 1970. The institute initiated the campaign to make the traditional rights on forest and its judicious utilization user-friendly to the local people.

CONSERVATION THROUGH ECO-DEVELOPMENT CAMPS

Following a steady decline in natural resources in Uttarakhand, an observation was made that merely protecting the existing bio-resources would not improve the livelihood of the people and the terrain conditions. Towards this end, the people made a humble beginning in the early 1970s to rejuvenate the resources through people's participation. This led to the concept of eco-development camps, where the local people with their traditional wisdom and specialists were encouraged to participate in introducing methodologies to develop their natural resource base. The objective was to not only create a natural resource base for the villagers, but also protect them from natural calamities such as flash floods, landslides, and soil degradation. In the last four years, there have been many encouraging results from the eco-development camps. An independent assessment was

made by the pioneering research organization, the Space Applications Center, the Government of India, which found that nearly 70%–80% of the terrain was covered with adequate forest. This improved the agricultural output and provided sufficient fodder to the livestock. It also provided fuelwood for the villagers in proximity. This was achieved because of the faith and confidence in the capability of the local people. The experiment demonstrated that if the conservation programmes are tuned to the needs of the local population, the terrain could be transformed to its pristine glory. Everyone knows and values the age-old community system (village panchayat) of governance in rural India. This system needs to be reinstated and should be made effectively operational.

SOME SUGGESTIONS

It is important to critically examine the present situation of the natural resource status in the Himalayas and design pragmatic policy and planning to improve the natural resource base. In order to have a holistic policy, it is essential to integrate traditional knowledge with the new scientific approach. Increasing consumerism and rapid advances made in the communication sector have converted the world into a market where commercial proficiency has focused on maximizing consumption. Tradition provides the people a way towards more sustainable use of natural resources. In this context, it would be pertinent to say that the complexities concerned with the World Trade Organization and intellectual property rights have given rise to newer problems. The contrast is clearly visible in complex issues vis-à-vis community skills and traditional knowledge. Consequently, it is important to first understand these complexities and contradictions and then change them according to the existing crises of the depleting natural resource base in the Himalayan ecosystem. Towards this end, the following suggestions are made.

1. Natural resources should be conserved and developed as per the local context and ecological demand of the terrain. For this, policies pertaining to biodiversity, which address issues at the macro level, should be formed.
2. An attempt should be made to reinstate the traditional knowledge of the hill communities in the policy document and make them capable of facing the emerging challenges in the changing world scenario. This would also mean that traditional knowledge should be kept out of the scope of the World Trade Organization and trade-related intellectual property rights.
3. The resource base should be redefined, wherein natural resources should not be taken as commercial resources. It also means that the exclusive local community ownership over the natural resources should be recognized.

In this context, Mahatma Gandhi can be quoted, who aptly said, “Earth provides enough to satisfy every man’s need, but not every man’s greed.” If this mantra were adhered to, it would definitely make a significant contribution in augmenting the natural resource base (*Translated from Hindi*).

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Conservation and Management of Bioresources in Uttarakhand, India

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Uttarakhand was created by separating the hilly region of the West Himalayas from the state of Uttar Pradesh. Its geographical area is 51 125 km². It lies between 28° 44' and 31° 28' North latitude and 77° 35' and 81° 01' East longitude. The state represents a unique geographical area, where the altitude ranges from 200 m to more than 2400 m above sea level, the latter comprising a magnificent series of snow-covered peaks. Broadly, the state of Uttarakhand can be divided into three regions: Himadri or greater Himalayas, Himachal or lower Himalayas, and Siwalik or sub-Himalayas. Of the total area, 47 325 km² of area is covered by mountains, while 3800 km² is the Terai plains. Uttarakhand has been traditionally divided into two parts, namely, Kumaon and Garhwal. The state has 13 districts, which are subdivided into 49 *tehsils* and 95 community development blocks.

The climate of the region varies from sub-tropical to temperate. The annual rainfall ranges from 1200 mm to 2500 mm, and the temperature varies from less than freezing point in the higher hills to more than 40°C in the plains. The state's climate is moderate and tropical, characterized by hot and dry summers; humid monsoon or rainy season; short and pleasant post-monsoon climate; and cool and dry winters. To some extent, the climate of the region is conditioned by its proximity to the Himalayas in the north. The average summer temperature ranges from 12.6°C to 18.7°C, whereas the winter temperature ranges from 2.9°C to 11.5°C. Rainfall peaks during July (15.5 mm average), followed by August (14.1 mm average). Monsoon season is characterized by high relative humidity, and the maximum relative humidity is experienced during July and August (95.5%–99.2%). The mountainous areas also experience mist, dew, and fog during the monsoon (Kandari and Gusain 2001).

The state has a wide network of perennial and seasonal streams. It is well drained by numerous rivers and rivulets (locally known as *gad*, *gadhera*, and *naula*). There are three main river systems: (i) Bhagirathi–Alaknanda basin–Ganga basin, (ii) Yamuna–Tons basin, and (iii) Kali system. The Ganga

system drains the major part of the state comprising the entire Garhwal region (except the western part of the Uttarkashi district) and the western part of the Garhwal Himalayan region from an altitude of 7138 m, with the confluence at Devprayag. The Bhagirathi is the main stream. The main tributaries to Alaknanda and Bhagirathi, or to one another, ultimately contributing to the water in the Ganga, are Alaknanda, Atagad, Berahi, Bhilangana, Dauli Ganga, Ganga, Haipur, Jad Ganga, Kaldi Gad, Madhu Ganga, Mandakini, Nandakini, Pindar, and Saraswati. The Nayar, which drains more than half the area of the Garhwal district, is an important tributary of the Ganga. The Yamuna–Tons system is also located in the Garhwal region. The River Yamuna originates at Yamunotri and is joined by important tributaries like the Giri, and more importantly, the Tons, which is its biggest tributary (Uniyal, Sharma, Choudhary, *et al.* 2007).

The state has a good cover of forest. About 3466000 hectares (ha) of the land is covered by forest, which is about 62.27% of the geographical area of Uttarakhand (FSI 2000). The Uttarakhand Himalayan region is very rich in forest resources and biodiversity. The plant diversity is extremely rich in the regions ranging from the valleys to the highly elevated alpine meadows, locally known as *kharak* or *bugyal* (Kumar, Bahuguna, Rawat, *et al.* 2002; Sethi, Bhujang Rao, Mohan, *et al.* 2002).

The alpine and tropical rainforests that cover most parts of the state are natural habitats for some of the well known wildlife species. The Corbett Tiger Reserve is home to the Royal Bengal Tiger. The Rajaji National Park, famous for its large number of pachyderms, is another rainforest in the region. Alpine forests in the region are found in the Valley of Flowers National Park (known for its amazing variety of flowers), Nanda Devi Biosphere Reserve, Govind National Park, and Gangotri National Park. To ensure proper management of forests, the forest area is divided into three categories: reserve forests, constituting 70% of the area under forests; civil and soyam forests (about 22% of the total forest area); and van panchayats accounting for about 8% of the area under forests. Thus, the most crucial aspect of the forest management in the region is the conservation-based forestry that meets the livelihood needs of the local people.

Agriculture is the mainstay of the people in Uttarakhand. More than 75% of the population is either engaged in agriculture or its allied practices. In the mainland of Uttarakhand, traditional subsistence agriculture is the dominant form of the farming system, but it is not viable in terms of ensuring sustainable livelihood. Therefore, the rate of migration from the region is high. Rice, wheat, millets, barley, pulses, and oilseeds are among the principal crops grown in the entire state. The ratio of pulses and oilseeds is comparatively low. Diverse food grains, vegetables, fruits, oilseeds, and pulses are found in all the altitudinal climatic zones of the state. The favourable climatic conditions and diversity in crops result in sustainable farming. The percentage of cropped area is highest

for wheat (33.54%), followed by rice (23.51%). In addition, the area under vegetable cultivation is expanding steadily and now accounts for 12.45% of the total cropped area in the state (Sati 2005).

The different climatic regions in the state are suitable for growing different types of temperate, sub-tropical, and tropical fruits. Additionally, there is a wide scope for growing different kinds of flowers, ornamental plants, mushrooms, and medicinal plants in the different climatic zones. The total land area under fruit cultivation is 190 192 ha and that under vegetable cultivation is 80 332 ha, accounting for 29% and 15% of the total area sown, respectively. Apple is the most important fruit grown in the region, and it is cultivated on 54 000 ha of land. Among various vegetables grown in the state, potato is the most important vegetable crop. Fruits are grown in the different altitudinal zones in the state, and the most important among them are apple, peach, citrus, mango, plum, apricot, walnut, litchi, and other fruits.

Uttarakhand has been traditionally known as the *gold mine* of medicinal plants. The state declared itself as the *herbal state* in 2003 and has plans to develop the medicinal plant sector on priority. Herbs are grown naturally in the meadows (*kharak*). The state boasts of extensive meadows along the great Himalayan range. The herbs found in the region are locally utilized for medicinal purposes, with positive results (Kumar, Bahuguna, Rawat, *et al.* 2002; Sethi, Bhujang Rao, Mohan, *et al.* 2002).

Along with agriculture, livestock farming is also the main occupation of the people of the state. The climatic conditions are extremely conducive for rearing animals. Sheep and goats are reared in the high altitudinal mountain regions. They are reared in the forest-cleared grasslands. These pasturelands (*kharak*) are usually located above 2000 m. Cows are reared in the middle and low altitudinal regions. They are the major source of milk for the region. A very small proportion of cross-bred animals is also reared in the state. Goats, sheep, horses, and ponies are used for transporting goods. Cattle, including cows and buffaloes, account for 67.78% of the total livestock farming. Cows are the preferred animals for livestock rearing (41.79%), followed by buffaloes (23.72%) and goats (23.52%) (State Board for Livestock, Dehra Dun, 2008).¹

In Uttarakhand, fishing is practised mainly in the fast flowing rivers and tributaries, natural and man-made lakes, ponds, and reservoirs. The total available length of principal rivers and tributaries is reported to be 2138 km. The natural lakes in the state occupy an area of about 262 ha, and the ponds in the plains of Dehra Dun and Udham Singh Nagar cover about 344 ha. Additionally, five man-made reservoirs of 1205 ha area offer wide scope for fish farming in the state under the aegis of the Uttarakhand Matsya Vikas Nigam Ltd (Kumar, Bahuguna, Rawat, *et al.* 2002; Sethi, Bhujang Rao, Mohan, *et al.* 2002).

¹ Personal communication.

4 Community-based Biodiversity Conservation in the Himalayas

The state's rich and varied bioresources have always attracted naturalists, wildlife enthusiasts, taxonomists, and conservationists, who have extensively explored these rich resources. Comprehensive information on the floral and faunal diversity of the state is recorded in the *Flora and Fauna of India* and subsequently in a series of publications by various government and non-government agencies, including the Botanical Survey of India, Zoological Survey of India, Forest Research Institute, Wildlife Institute of India, Navdanya, Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), and many colleges and universities in the state (Kumar and Rawat In press).

BIODIVERSITY IN UTTARAKHAND

The state of Uttarakhand has rich and diverse floral, faunal, and microbial wealth, including rare and threatened species of plants and animals. The state's biodiversity is extremely important as it helps the region maintain its vitality, and therefore, its conservation is both essential and necessary. Uttarakhand is also characterized by close relationship between the religious and socio-cultural beliefs and conventions. The sacred groves of the state are held in high cultural and religious esteem by the local folks.

The diverse forest types in the state, grasslands, different types of traditional land use patterns, and traditional agricultural practices contribute to the varied biodiversity of the state. The traditionally valued natural systems at various levels should be integrated with legal and policy-level interventions for better conservation and effective management of biodiversity outside the protected areas. The state has a wide spectrum of habitats, including two kinds of grassland: (1) grassland in plains (*chaur*) with dominant species of *Bassi*, *Ulla*, *Jarakush*, *Sindhur*, and *Tinna* and (2) alpine grassland or *bugyal* consisting of many medicinal and insectivorous plants.

The rich floral diversity of the state comprises 5080 species of angiosperms and gymnosperms. Large varieties of rice and other cereals like mandua, amaranth, pulses, and vegetables are grown in the state. There exists an immense wealth of medicinal plants, wild edibles, and timber- and fibre-yielding plants. The rural community is largely dependent on these for their livelihood. Over the past decades, the exploitation of ethno-botanical resources has become a flourishing trade, but with time, the trend has shifted towards overexploitation. Destruction of natural habitats coupled with tourism activities have led to the deterioration of important plant habitats and eradication of commercially valuable species. The state needs proper action plans to combat threats to the biodiversity. Uttarakhand is home to 4894 species of birds, mammals, and reptiles.

The state tree of Uttarakhand is burans (*Rhododendron arboretum*), the state flower is brahm kamal (*Saussurea obvallata*), the state animal is musk deer (*Moschus chrysogaster*), and the state bird is monal pheasant (*Lophophorus impejanus*).

Microbial Diversity

The rich microbial diversity of the state comprises about 1618 species of various microbes, as summarized in Table 1. These include bacteria, fungi, diatoms, and protozoa.

Table 1 Microbial diversity of Uttarakhand

<i>Group</i>	<i>Number of species</i>
Bacteria	93
Fungi	1226
Diatoms	264
Protozoa (Coccidia)	35

Sources Bisht and Srivastava (1983); Nautiyal, Nautiyal, and Singh (1996); Sati (1997); Nautiyal and Nautiyal (1999); Uniyal (2001); Srivastava and Singh (2005); Selvakumar, Kundu, Gupta, *et al.* (2007)

Floristic Diversity

Floristically, Uttarakhand falls under the West Himalayan Biogeographic Zone. Situated in the lap of the Himalayas, the region is rich in forest wealth, which ranges from subtropical to alpine species. As stated before, the forest area of the state comprises 64.8% of the state forest geographic area. The flora of the state ranges from tropical deciduous to alpine vegetation, broadly categorized into three major types, namely, subtropical, temperate, and subalpine and alpine.

The flora comprises 6494 species belonging to eight groups, namely, algae, bryophytes, pteridophytes, lichens, gymnosperms, monocots, orchids, and angiosperms (Table 2). The dominant families of angiosperms in the state are Asteraceae, Brassicaceae, Cyperaceae, Fabaceae, Lamiaceae, Poaceae, Ranunculaceae, Rosaceae, and Scrophulariaceae.

Table 2 Floral diversity of Uttarakhand

<i>Group</i>	<i>Number of species</i>
Algae	32
Bryophytes	478
Lichens	539
Pteridophytes	365
Gymnosperms	35
Monocots (excluding orchids)	1021
Orchids	238
Dicots	3786

Sources Gaur (1999); Srivastava and Singh (2005); Uniyal, Sharma, Choudhary, *et al.* (2007); Jalal, Kumar, Rawat, *et al.* (2008); Punetha and Kholia (2010); Shantanu and Uniyal (2010); Sharma, Semwal, and Uniyal (2010); Upreti, Nayaka, and Chatterjee (2010)

MEDICINAL AND AROMATIC PLANTS

Uttarakhand, traditionally known as the gold mine of medicinal plants, falls under the West Himalayan Biogeographic Zone and is a rich repository of medicinal plants.

The three main agro-ecological zones, that is, (1) the alpine zone, (2) the temperate zone, and (3) the subtropical zone, have significant physiographic differences, mainly in terms of altitude, aspects, hill slope, and soils, which have resulted in the development of diverse medicinal plants.

The herbal state plans to develop the medicinal plant sector on priority. The Herbal Research and Development Institute (HRDI) under the Department of Horticulture at Gopeshwar in the Chamoli district was identified as the nodal agency for the sector in the state.

The alpine flora, an integral part of the fragile ecosystem of the mighty Himalayas, has been a matter of concern for all the people involved in environment protection activities, medicinal plant trade, and conservation. These slow growing medicinal plants that have been exposed to the extreme environmental conditions—sometimes these remain buried under snow for a considerable period of time—hold vast potential to serve as remedies for various diseases. Ever since the local people and the outside world discovered the medicinal properties of the various medicinal plants growing in the region, these species have faced tremendous pressure due to heavy exploitation for commercial gain, which has consequently resulted in a decline in their population. The plants mentioned in the traditional systems of medicines like the Ayurveda and Amchi are rarely seen in the alpine meadows these days. Species of *Aconitum*, *Dactylorhiza*, *Fritillaria*, *Microstylis*, *Polygonatum*, *Podophyllum*, and *Picrorrhiza* have huge market potential, but are now restricted to either inaccessible areas or to the protected habitats due to overexploitation and many other anthropogenic and environmental factors. As most of these species are critically endangered, efforts have been made to assess the threat to these species (Table 5).

Research institutes such as the High Altitude Plant Physiology Research Centre in the state have standardized the cultivation techniques for the species of *Aconites*, *Dactylorhiza*, *Picrorrhiza*, and *Podophyllum*, and are now promoting their cultivation on a large scale. Ex situ conservation could be one of the strategies for the conservation of these valuable species; however, in situ conservation, especially the ecosystem conservation approach, is far more important. The best way to implement conservation practices and promote sustainable utilization of these taxa is to create awareness among local people about their importance in conservation and livelihood support. Capacity building of the local community will be the most essential component for the long-term survival of these plants and their habitat.

Approximately 2364 plant species with medicinal properties and uses have been reported from Uttarakhand, as summarized in Table 3 (Pande, Tiwari, and Pande 2006).

Table 3 List of medicinal and aromatic plants in Uttarakhand

<i>Group</i>	<i>Number of species</i>
Plants used in Ayurveda	602
Plants used in treating human diseases and disorders	1340
Plants used in livestock health care	364
<i>Jari booties</i>	58
Important medicinal plants in short supply and prioritized for research and development	49
Medicinal and aromatic plants under cultivation/cultivation trials	96
Medicinal and aromatic plants cultivated/suggested for cultivation in different forest nurseries	68

Sources FRLHT: Encyclopaedia on Indian Medicinal Plants. FRLHT ENVIS Centre on Medicinal Plants; Kala, Dhyani, and Sajwan (2006); Pande, Tiwari, and Pande (2006).

Ethnobotanical Resources

Approximately, 318 species of plants with various ethnobotanical uses are reported from the state (Table 4). Among these, 13 species are used for preparing condiments and spices, 37 species are oil-yielding plants, 20 species are alcoholic and non-alcoholic beverage plants, 17 are listed for their use in religion and culture, 20 are used in art, craft, mattresses, and sports goods, 16 have sacred values and are used in various rituals, festivals or worshipped as sacred trees, while 5 species are associated with religious festivals in the state. Recently, 96 species of plants have been reported from the state for bioprospecting. Thirty-four plant species are recorded for their miscellaneous uses, such as for preparing dyes, insecticides, pesticides, brooms, and so on. In addition, the state has 44 species of wild timber yielding plants, and as many as 15 species are used for social forestry in Uttarakhand, even as bee forage.

Table 4 List of plants with ethnobotanical uses in Uttarakhand

<i>Group</i>	<i>Number of species</i>
Spices and condiments	13
Oil-yielding wild plants	37
Wild edibles used in beverages	20
Plants used in religion and culture	17
Plants used in arts, crafts, and sports goods	20
Sacred plant species	16
Sacred trees associated with religious festivals	5
Plants species useful for bioprospecting	96
Plants with miscellaneous uses	34

Sources Badoni and Badoni (2001); Anthwal, Sharma, and Sharma (2006); Gairola and Biswas (2008); Kumar and Rawat (In press)

Exotic and Cultivable Plants

Various species of exotic flora (435 species) are cultivated and grown in gardens, orchards, nurseries, and so on, representing human influence on the floristic composition of the state (Negi and Hazra 2007). In addition, tissue-cultured floriculture has taken root in the state in a big way in the recent years. Altogether, 17 cultivated exotic horticultural species and their varieties are being tissue cultured in the state (National Horticulture Board, Dehra Dun, 2009).

CONSERVATION STATUS OF FLORA

The rapid urbanization and changes in land-use patterns have adversely affected a large number of plant species. Consequently, 38 globally threatened plants, 65 species of threatened medicinal plants, and 312 species of threatened plants (under the Conservation Assessment and Management Plan [CAMP] criteria) have been reported from the state, as listed in Table 5. In addition, 252 plant species under the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora and 140 species of endemic plants have been reported from the state (Table 5). About 29 invasive alien plant species, mostly with origins in tropical America, have also been recorded from the state.

Table 5 Conservation status of flora

<i>Group</i>	<i>Number of species</i>
Endemic plants from Uttarakhand	140
Threatened (IUCN Red List) plants from Uttarakhand	38
Threatened plants (CAMP Criterion) from Uttarakhand	312
Threatened medicinal plants (CAMP Criterion) from Uttarakhand	65
Plants under CITES from Uttarakhand	252

IUCN – International Union for Conservation of Nature; CITES – Convention on International Trade in Endangered Species; CAMP – Conservation Assessment and Management Plan

Sources Nayar and Sastry (1987); Kumar, Bahuguna, Rawat, *et al.* 2002; Sethi, Bhujang Rao, Mohan, *et al.* (2002); CITES (Convention on International Trade in Endangered Species). 2003. Pictorial Identification Manual of CITES Plants in INDIA. Appendices I, II and III valid from 28 May 2003. CITES-listed species Database hosted by UNEP-WCMC. CITES Appendices.htm

Sacred Groves

In Uttarakhand, sacred groves have formed an integral part of the hill conservation system. The *dev van*, or sacred groves, were common particularly in the remote areas of the hills and were associated with religious places. Even today, such groves can be found on hilltops in practically every village in Garhwal, and small shrines dedicated to local deities are found in villages, grazing lands, forest paths, and agricultural fields. Most temples in Kumaon and Garhwal are located in or near a grove of trees. The Jageshwar temple

is surrounded by a dense deodar grove, which harbours a huge deodar tree reported to be older than the shrine itself. Several forest areas in Almora and Pithoragarh have also been dedicated to local deities. Since such religious practices are slowly coming to an end due to rapid urbanization, sacred groves such as the deodar grove near Jageshwar temple are now under threat. Eighteen sacred groves have been reported from the state (Anthwal, Sharma, and Sharma 2006). Nearly two dozen sacred groves have been established around the Berigad-Chowkori belt of Thal *tehsil* of Pithoragarh (Nagarwalla and Agrawal 2010).

Agrodiversity

Table 6 lists 1107 species of agricultural crops that are grown in Uttarakhand. These include traditional food crops, paddy, wheat and barley, cultivated and wild fruits, vegetables, grasses, fodder plants, mushrooms, and so on.

Table 6 List of agricultural crops in Uttarakhand

<i>Group</i>	<i>Number of species</i>
Traditional food crops	191
Paddy, wheat, and barley families	230
Cultivated wild fruits	133
Native vegetable crops	62
Wild leafy vegetables with medicinal uses	21
Wild edible seed grains	12
Commonly used fodder species	22
Grasses	167
Main indigenous natural fibres	28
Mushrooms	116
Edible mushrooms	22
Varieties of improved crops released by VPKAS	103

Sources Badoni and Badoni (2001); Shiva and Bhatt (2002); Srivastava and Singh (2005); Kumar and Rawat (In press)

Faunal Diversity

The state is very rich in faunal resources. The diversity of faunal components in Uttarakhand clearly indicates the extent of fauna restricted to the forest zone and above timberline. The richness of the fauna is distinctly higher in the forest zone, especially in the broad-leaved wet forest area, than in nival zone. The fauna includes a high percentage of Indo-Malayan elements, besides the Palaearctic affinities. There are few endemics also. A total of 4894 species, including 3935 species of invertebrates and 959 species of vertebrates, have been reported from the state (Table 7).

Table 7 List of faunal species

<i>Sl. No.</i>	<i>Group</i>	<i>Number of species</i>
A	Invertebrates	3935
	Trematodes	48
	Cestodes	36
	Nematodes	196
	Mollusca	128
	Annelida	69
	Crustacea (Decapoda)	20
	Chilopoda	32
	Arachnida	249
	Insecta	
	Collembola	31
	Thysanura	04
	Odonata	163
	Plecoptera	20
	Orthoptera	116
	Dermaptera	43
	Isoptera	52
	Hemiptera	479
	Coleoptera	416
	Lepidoptera	567
	Trichoptera	60
	Hymenoptera	234
	Ichneumonidae	302
	Diptera	670
B	Vertebrates	959
	Pisces	142
	Amphibia	20
	Reptiles	75
	Birds	622
	Mammals	100

Sources Arora and Kumar (1995); Khanna (2003); Mohan and Sinha (2003); Rizvi (2007, 2008); Kumar and Rawat (In press); ZSI (2010)

Conservation Status of Fauna

The trade and utilization of faunal resources for various purposes constitute a serious threat to their biodiversity. Among the major species, musk from the Himalayan musk deer (*Moschus chrysogaster*), bile from the Himalayan black bear (*Ursus arctos*), mammalian furs, wool, and butterfly form the “backbone of the species in trade” from the state (Kumar, Bahuguna, Rawat,

et al. 2002; Sethi Bhujang Rao, Mohan, *et al.* 2002). The updated list of the globally threatened Indian fauna, including the ones in the CAMP list and the species listed under Wildlife (Protection) Act, 1972, and CITES, is presented in Table 8.

Table 8 List of threatened fauna and species requiring conservation in Uttarakhand

<i>Group</i>	<i>Number of species</i>
Threatened fauna (IUCN Red List)	96
Fauna under CITES	97
Fauna under Schedule I of Wildlife (Protection) Act, 1972	97
Medicinally used wild animals by tribes	38
Trouts, snow trouts, mahaseer, and carps	12
Threatened fauna (CAMP Criterion)	141
Restricted range bird species	7
Livestock population	11

IUCN – International Union for Conservation of Nature; CITES – Convention on International Trade in Endangered Species; CAMP – Conservation Assessment and Management Plan

Sources Walker and Molur (2000); Gusain and Gusain (2001); Kumar, Bahuguna, Rawat, *et al.* (2002); Sethi Bhujang Rao, Mohan, *et al.* (2002); Kumar and Khanna (2006); Negi and Palyal (2007); Kumar and Rawat (In press)

Fossil Diversity

A total of 259 fossil forms of microbes, flora, and fauna have been reported from the state (Table 9).

Table 9 List of fossil species

<i>Group</i>	<i>Number of species</i>
Microbes	75
Flora	34
Fauna (Invertebrates)	129
Fauna (Vertebrates)	25

Sources Diener (1908); Gupta (1971); Lakhani Pal, Maheshwari, and Awasthi (1976); Prakash (1988); Phadtare (1989); Tiwari (1999)

MAJOR BIODIVERSITY-RELATED ISSUES

As the state was formed very recently, and many developmental and planning activities will take place in future, there is a real threat to the ecosystem if one does not take care of the impacts of the developmental projects and tourism. The major threats cited are habitat degradation due to illegal, commercial, and development activities, especially around the catchment areas; extraction of timber;

deliberate forest fires; overgrazing and trampling of saplings; diversion of forest land for non-forest purposes; exotic species and weed infestation; horticulture at the expense of temperate biodiversity; overexploitation of medicinal plants; faulty agricultural practices; soil degradation; mining; construction of large dams; pollution in waterbodies; indiscriminate use of fertilizers and pesticides; poaching; and illegal trade in wildlife products.

Although the state is well endowed with biological resources, the past decades have seen an increase in pressure on the state's natural ecosystems. The forest cover in the entire Siwalik ecosystem of Uttarakhand has been virtually degraded. The high altitude grasslands (*bugyal*) are under enormous pressure from local and migrant grazier communities. Glaciers are receding, and agro-diversity is shrinking because of the introduction of exotic varieties and adoption of monoculture practices. Livestock diversity has been marked by the loss of many of the native varieties (like *kali gai*) due to the introduction of new breeds, poor health management, and mismanagement of fodder production and cultivation. Ethno-botanical resources, which are one of the prime sources of livelihood in the state, are also declining. It is, therefore, necessary to develop a comprehensive plan for the state, which would ensure conservation and sustainable use of biodiversity.

ONGOING INITIATIVES AND KEY GAPS

Uttarakhand has a protected area (PA) network of national parks (Corbett, Valley of Flowers, Rajaji, Gangotri, and Govind) and wildlife sanctuaries, namely, Govind Pashu Vihar, Kedarnath, Askote, Sonanadi, and Mussoorie, and world heritage sites like the Nanda Devi Biosphere Reserve. There are also a large number of community-conserved areas, including van panchayats and other informally protected forest areas around the villages, grasslands such as *bugyal*, and wetlands. In many places, the traditional practices of common property resource management have helped in the conservation of biodiversity, both of ecosystems and of species. For ex situ conservation, various institutes have arboretum, populatum, and bambusetum for flora, and various research activities are being undertaken to identify the status of flora in the state. For ex situ conservation of animals, only one high altitude zoo in Nainital, two musk deer breeding centres at Kanchula, Kharak, and Dharamgarh, and one mini-zoo in Almora are in operation. There are gaps in the information on the status of micro-flora and fauna, which still need to be addressed. The management of the PA network and the procedure leading to the identification of biodiversity hotspots with conservation value need to improve. The soil conservation programme of the forest department includes six schemes—development of civil soyams in Kumaon and Garhwal, river valley projects in the catchment area of Ram Ganga, integrated wasteland development projects, integrated watershed management, and the Kheerganga project, and reclamation and rehabilitation of

abandoned mines of Mussoorie hills. Five man-made reservoirs under the aegis of Uttarakhand Matsya Vikas Nigam Ltd provide potential for fish farming. However, still there are some challenges in the form of conservation of golden mahaseer, lack of control and regulation of illegal fishing, and introduction of exotic fish.

To regenerate native varieties, the traditional agro and seed conservation practices will have to be revived. Livestock diversity needs a proper fodder development programme, policy, and implementation strategies to conserve the native varieties. Ethnobotanical species are strongly linked to the livelihood of the rural community and need to be studied vis-à-vis their habitat protection, research and monitoring, and regeneration schemes. People's movements such as the *Beej Bachao Andolan* and the efforts of non-governmental organizations (NGOs) linked to the villagers, such as the one by Navdanya, at places like Munsiri and Nahin Kalan, have aided in highlighting the deterioration of agrodiversity and have attempted to revive it in many different ways. The importance of biodiversity has been introduced in the curriculum of schools. The forest department has come up with a unique initiative of rewarding the forest staff and rural people for their conservation efforts (Kumar, Bahuguna, Rawat, *et al.* 2002).

The Ministry of Environment and Forests (MoEF), the nodal agency for implementing provisions of the Convention on Biological Diversity (CBD) in India, developed a strategy for biodiversity conservation at the macro level in 1999 as part of the environment/development planning process with the support of the Global Environment Facility (GEF)/United Nations Development Programme (UNDP). Kalpavriksh, an NGO, undertook the technical execution of the project, and the Biotech Consortium India Ltd coordinated the administrative execution of the same. A comprehensive document on the Biodiversity Strategy and Action Plan (BSAP) was prepared for the country, including Uttarakhand (Kumar, Bahuguna, Rawat, *et al.* 2002).

THREATS TO UTTARAKHAND'S BIODIVERSITY

The major threats to the state's biodiversity are mentioned in the following sections (TPCG and Kalpavriksh 2005).

Increase in Urbanization

According to the 2001 census, the total population of the state is estimated to be 8.47 million. As stated before, since the state is new, and many developmental planning activities will materialize in future, there is a real threat to biodiversity if the impacts on the environment are not taken care of before initiating any developmental project. The people of the state are keenly aware of the importance of their natural resources and want sustainable development in the state.

Overgrazing and Illegal Collection from North-West Frontier Province

Grazing and trampling of saplings by the livestock are the biggest threats to the regeneration of vegetation in all the forested areas of the state. The requirement for green fodder is estimated to be 25.9 million tonnes (MT) per annum, based on the livestock census of 1993. However, the total productivity from forests and pastureland is estimated at 4.35 MT. This gap is because of the illegal activities, such as heavy lopping of trees, cutting of saplings, and collection of barks/branches of the trees. Coupled with this, the illegal activities undertaken in North-West Frontier Province (NWFP), such as honey collection, fuelwood gathering, and so on, lead to higher prevalence of fire and poaching of wildlife.

Replacing High Altitude Biodiversity with Horticulture

The high altitude oak forests of Uttarakhand are under threat as they are increasingly being replaced with horticulture crops such as apple. The oak forests are degraded due to overexploitation by the local communities, who are dependent on oak leaves for fodder, on wood for fuel, and on timber for farm implements. Oak forest soil is rich in humus and is often used as supplementary manure. Agricultural activities frequently extend into the oak forest region, and with increasing demand for fodder and firewood, trees are being repeatedly lopped and seed output is getting reduced.

Overexploitation of Medicinal Herbs and *Bugyals*

Most of the high altitude grasslands (*bugyal*) of the state are under pressure due to grazing by livestock reared by both migrant and local communities. Additionally, migratory grazers (*gaddi*) and tourists add to the pressure by collecting fuelwood. Further, the extraction of medicinal herbs in these areas by the locals, generally employed by multinational drug and pharmaceutical companies, exacerbate this pressure.

Exotic Species and Weeds

The proliferation of *Lantana* and *Parthenium* is affecting the biodiversity in Uttarakhand, both in PAs and non-PAs. Vast areas in the southern flat terrain area and the riverine areas at Motichur are infested with *Lantana*. Water hyacinth also poses a major problem in the wetlands, and efforts should be made to free these waterbodies from weed infestation.

Poaching and Illegal Trade

Uttarakhand witnesses a flourishing trade in wildlife and its derivatives. The wide diversity of animals makes it a hotspot for such thriving illegal trade in northern India. The poachers trade in birds, mammals, and reptiles.

There is a well-established network of illegal trading of medicinal plants from the wild and overexploitation of valuable medicinal plants like *yartsa gombu*, *kuth*, and *yew* in Uttarakhand.

CONSERVATION STRATEGIES AND ACTION PLAN

It is necessary to develop a comprehensive plan for the state to ensure that the concepts related to conservation and sustainable use of biodiversity are better understood and managed.

The MoEF, Government of India, initiated an exercise (1999) as part of the environment/development planning process under a project funded by the GEF/UNDP. Kalpavriksh was requested to undertake the technical execution of this project. In the meantime, the development of a state-level biodiversity strategy and action plan was also initiated under the World Bank assisted Uttar Pradesh Forestry Project (2002), which was implemented through a consultative process involving multiple stakeholders by The Energy and Resources Institute (TERI), New Delhi. In 2002, a comprehensive biodiversity and action plan was prepared for the state jointly by the State Forest Department, Uttarakhand; TERI; and the Zoological Survey of India (Kumar, Bahuguna, Rawat, *et al.* 2002).

The issues and objectives related to the conservation and sustainable use of biodiversity, which were identified as key elements to the development of such a strategy (and which were addressed in the strategy and action plan), include identification of flora, fauna, agro-biodiversity, and plants of ethnobotanical importance and their conservation strategies (TPCG and Kalpavriksh 2005).

The various goals of conservation strategies are as follows.

- Conserving the natural heritage of the state, including the unique, rich biodiversity, and fragile ecosystems, such as forests, grasslands, wetlands, and mountains; wild and domesticated biodiversity; genetic resources; and ecological and environmental processes.
- Giving priority to in situ conservation of the state's biological and cultural diversity located both within and outside the state's protected areas.
- Ex situ conservation of flora, fauna, and floral and faunal genetic resources.
- Developing strategies and actions for the conservation of agriculture, livestock, fodder, and ethnobotanical diversity.
- Using biodiversity and natural resources sustainably.

The state has taken several steps for the protection, conservation, and management of biodiversity, including the creation of PAs, designation of protected trees, and the preservation plots.

In situ Conservation

Protected area network

Compared to the national average of 4.75%, Uttarakhand has a high percentage of land under the protected area network (PAN). There are six national parks, six wildlife sanctuaries, one biosphere reserve, one world heritage site, two elephant ranges, and two conservation reserves, covering an area of 0.73 million ha, constituting 13.68% of the state's geographic area.

Protected trees

In Uttarakhand, 27 species of trees, numbering about 114, are designated as protected trees for their superior morphological and genetic characteristics. These species are scattered over hills and plains of the state in various forest types.

Preservation plots

The representative areas set aside in various forest types for permanent protection are known as preservation plots. The main objectives of these preservation plots are (1) to preserve the existing forests as far as possible in their present form, and (2) to protect forest plots from all forms of injury and to permit progression towards climax form. Most of the preservation plots and protected trees are located in the reserved forest areas. However, some of them are outside the PAs (Kumar, Bahuguna, Rawat, *et al.* 2002).

Ex situ Conservation

Through its zoos and conservation breeding centres, the Uttarakhand Forest Department is working towards the conservation and rejuvenation of the endangered and threatened species of fauna. Currently, the state has two musk deer breeding centres, one zoological garden, two botanical gardens (one each in the Forest Research Institute [FRI] and the Botanical Survey of India), three arboretums, one bambusetum, and one medicinal plant nursery. The major institutes working towards the conservation of plant diversity are the FRI; Wildlife Institute of India; Botanical Survey of India; G B Pant Institute of Himalayan Environment and Development (GBPIHED), Kosi-katarmal, Almora; and Centre for Aromatic Plants (CAP), Selaqui. The GBPIHED wants to undertake a medicinal plant conservation programme under the aegis of the Department of Biotechnology, Government of India, in collaboration with the National Botanical Research Institute (NBRI) and Botanical Survey of India.

In Uttarakhand, arboretums are located at Kalika near Ranikhet; FRI, Dehra Dun; and GBPIHED, Kosi-katarmal. The arboretum initiated by the GBPIHED at Kosi-katarmal includes a collection of rare and endangered medicinal, edible, multipurpose species, orchids, and ferns numbering over 300 species. Lal Kuan populatum near Haldwani has a collection of more than 400 clones of the *Populus* species. The FRI, Dehra Dun, boasts of the only bambusetum of the state with a rich collection of bamboo species.

The state has one high altitude zoo in Nainital, two musk deer breeding centres in Kanchula Kharak and Dharamgarh, and one mini-zoo in Almora. The only high altitude ex situ conservation site of Uttarakhand is located in the city of seven lakes—Nainital. The zoo occupies an area of 4.693 ha adjoining the reserved forests of Nainital. The zoo is identified by the Central Zoo Authority of India (CZA) as the breeding centre for high altitude animals of the state. The Van Chetna Kendra in Almora, established in 1981, also harbours a high altitude mini-zoo. It occupies an area of 32 ha of land. The zoo is located at Kanchula kharak in Kedarnath, and was established with an aim to breed and re-stock faunal diversity. Another zoo is located in the Mahroori village in the Dharamgarh taluk of Pithoragarh district and was established with the objective of breeding musk deer in captivity for the extraction of musk (Kumar, Bahuguna, Rawat, et al. 2002; Sethi, Bhujang Rao, Mohan, et al., 2002).

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