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Status of Biodiversity in Central Himalaya

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Abstract The variety of plants, animals and microorganisms reflect the biodiversity of that area. Uttarakhand state falls under Central Himalaya which is rich in biodiversity as this area exhibits large number of plants and animals. There are about 7000 species of plants and 500 species of fauna in Uttarakhand state. Contribution of floral diversity is 31% of total floral density of India whereas fauna contributes just 1.58% of the total faunal density of the country. Besides, there are 119 endemic species of flowering plants in the state that exhibited 2.35% endemism and 35 faunal endemic species including 11 vertebrates and 24 invertebrates. Many plant and animal species are threatened, rare or becoming extint therefore some major initiatives have been taken such as 6 wild life sanctuaries, 5 national parks, one conservation reserve and one biosphere reserve has been established apart from this few herbal gardens, arboretums, parks, zoos, medicinal and aromatic plant area, sacred grooves have been made by the state government to save them for sustainable ecological balance. Unfortunately for the last few years biodiversity of the area is declining and now it's important to strenthern existing policy of the state. In the present paper, an attempt has been made to assess the status of biodiversity of Central Himalaya.

Keywords: *biodiversity, non timber forest produce, medicinal and aromatic plants, traditional farming systems, flora, fauna, policy*

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1. Introduction

Biodiversity of an area play a very important role in terms of providng direct and indirect benefits. Direct benefits are in terms of goods i.e. food, fodder, fuel, medicinal plants, aromatic plants and non timber forest produce (NTFPs) whereas indirect benefits are ecosystem services and climate regulation. The Convention on Biodiversity estimated that 40 % of the world's economy and 80 % of the needs of the poor are derived from biological resources [1]. Biodiversity boosts ecosystem productivity where each species has a definite role to play. For example, a larger number of plant species means a greater variety of crops, greater natural sustainability for all life forms, and healthy ecosystems that can better withstand and recover from a variety of disasters. Recognizing the importance of biodiversity, it's a duty of each person to conserve it. Unfortunately, for the decades due to overexploitaion of natural resources biodiversity have registed rapid erosion that impacted whole ecosystem. Now it is need of the hour that people on the earth should be educated to understand the importance of the biodiversity and the implication of the biodiversity loss. There is an urgent need to assess the vulnerability of biodiversity and identify the issues that will help for taking up mitigation measures not only to manage and conservation of biodiversity but for its sustinbility [2,3,4,5].

Uttarakhand Himalayan Region i.e. Central Himalaya is rich in its flora and fauna and is also known as a natural reservoir. This state is well known for its biodiversity. It is estimated that there are about 7000 species of plants in the state though till date only 85% flora explored. Similarly the state comprised 500 species of fauna of which 80% are invertebrates and 20% are vertebrates [6,7,8,9,10].

2. Materials and Methods

Uttarakhand state falls under Central Himalayan region of India. It comprises of Kumaun and Garhwal regions in the state. The state of Uttarakhand situated in the Central Himalaya at $29^0$5' north latitudes to 31^0 25' north latitudes and $77^0$45' east longitudes to 81^0 north longitudes. Elevation ranges from 300 m to 7000 meters above sea level covering a geographical area of 53,485 sq km. The climate of the state is sub tropical in valleys and it is temeperate in hills. According to 2011 Census, the total population of the state is 10,086,292, out of which 70 percent lives in rural areas. Main source of livelihood are agriculture and animal husbandry which is subsistence type. Traditional crop-livestock mixed farming continues to be the basis for livelihoods and economy of local communities [11] (Rao and Saxena 1996). States is rich in bioresources and have tremendous potential in it. People have close linkages with the nature and derive many goods and services from natural resources. The region exhibits plenty of natural resources, and considered a mega hot spot of biodiversity. State is a hub of many medicinal and aromatic plants. A number of life saving drugs have been derived from traditional folk medicinal herbs [12] (Ved Prakash, 2001). Due to above characteristics, the area has been selected for the study (Figure 1). Information has been collected from different sources through literature survey, searching internet and

by collecting available data on the subject, involving compilation and analyses of informations, research papers/reports, media reports and articles from various libraries.

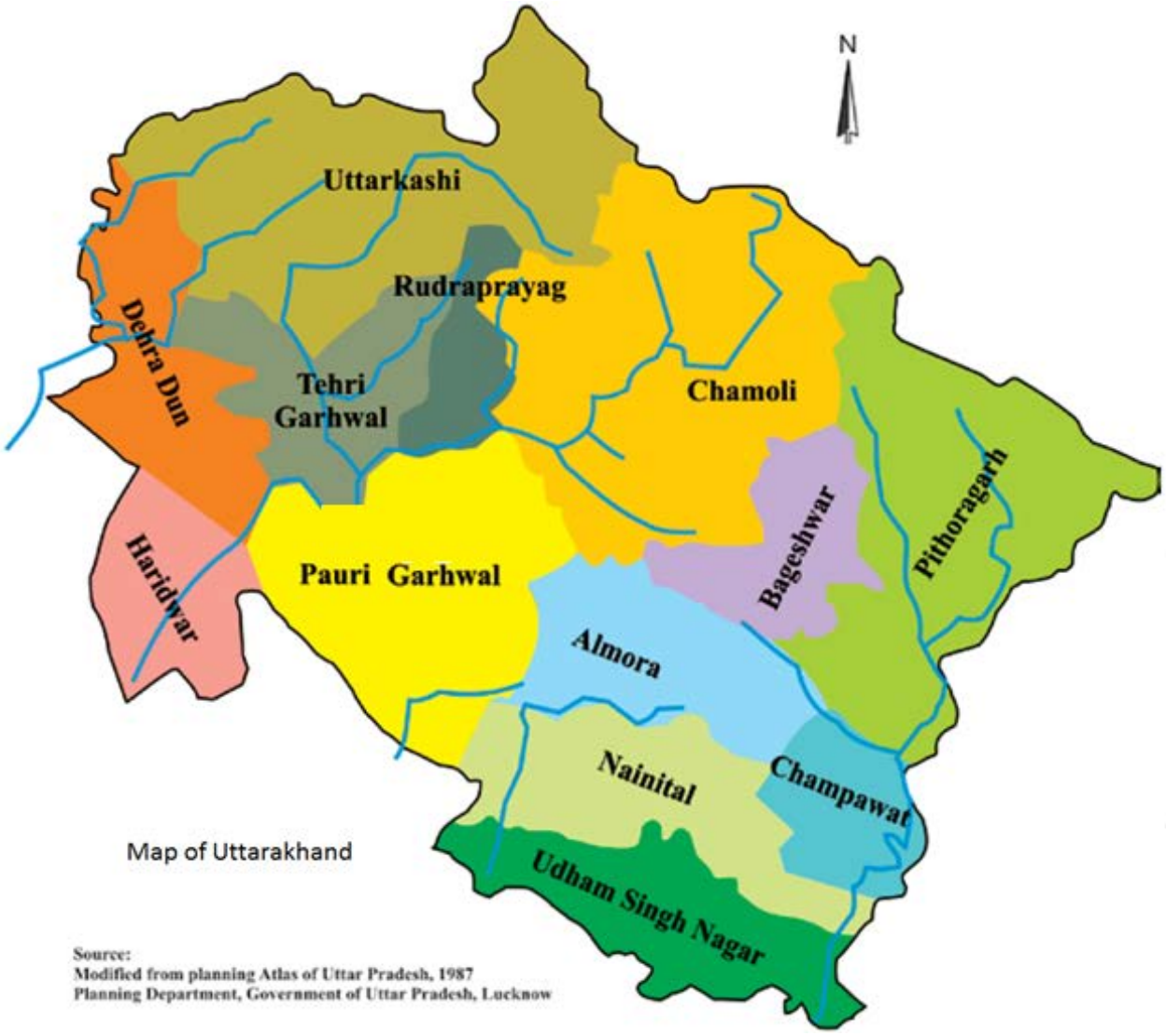

Figure 1. Map of Uttarakhand

3. Results

Present paper highlights the different sectors that represent the biodiversity of the state. In the present study, some important natural resources e.g. forests, medicinal and aromatic plants have been presented. Besides this information, agiculture diversity, horticulture, floriculture, ethnobotanical plants, faunal diversity, major initiatives and policies for biodiversity conservation have also been described as follows:

3.1. Forests

Uttarakhand Himalaya is very rich in forest resources and diversity. Forests are important natural resource of the state. They play a very vital role for the sustanance of the population and are the storehouse of the biodiversity as well as play a vital role in regulating climate cycle. Forest diversity is the main source of livelihood of the people living in Uttarakhand, Central Himalaya.

The forest area is reported to be 3,466 thousand hectares and accounts for around 62.27 % of the area of Uttarakhand. Mainly the forests are of alpine and tropical rainforests that cover most parts of the state. The plant diversity is found extremely rich from the valley regions to the alpine meadows, locally known as kharaks or bugyals [13]. India is one of the important megabiodiversity centres of the world, where Himalayas contributes maximum in maintaining ecosystem. Biodiversity is used in different ways as it provides fodder, fuel wood, timber, leaf litter for manuring crop fields, construction, industrial raw material and several non-timber forest produce. *Pinus roxburghii sarg.* (Chir Pine) and *Quercus leucotrichophora* are dominant plant species in the forests of this region [4]. The main forest types of the state according to altitude are described as follows: (1) Deodar forests (Cedrus deodara), Blue Pine forests (Pinus wallichiana),) Chir forests (Pinus roxburghii), Teak forests (Tectona grandis), Bamboo forests (Dendrocalamus spp., Oak forests (Quercus sp.), Fir (Abies pindrow) and Spruce (Picea smithiana) [Figure 2]. Due to increasing population deforestraion has registered a sharp decline in forest resources that has resulted degradation of forest and deterioration of environment.

Figure 2. Floral biodiversity in Uttarakhand, India

Table 1. Major medicinal and aromatic plants (MAPs) being promoted for cultivation in the state of Uttarakhand [3,13,14]

Sr No.	Species	Botanical name
1	Kutki	*Picrorhiza kurrooa* Royle ex. Benth
2	Kuth	*Saussurea costus* (Falc.) Lipschitz, syn.
3	Jatamansi	*Nardostachys jatamansi* DC
4	Chirayata	*Swertia chirayata* (Wall.) C. B. Clarke
5	Bankakri	*Podophyllum hexandrum* Royle
6	Sarpgandha	*Rauvolfia serpentine* (L.) Benth. ex Kurz.
7	Kalihari	*Gloriosa superb* L.
8	Atis	*Aconitum hetrophyllum* Wall
9	Jamboo/Faran	*Allium stracheyi* Baker
10	Kalajira	*Carum carvi* (LINN.) */Bunium persicum* Bioss.
11	Tilpushpi	*Digitalis lanata* Ehrh
12	Stevia	*Stevia rebaudiana* (Bert.) Bertoni
13	Pyrathrum	*Chrysanthemum cinerariaefoliumVis.*
14	Large cardamom	*Ammomum subulatum* Roxb.
15	Chhippi	*Pleurospermum angelicoides* (Wall. ex DC.) Benth. ex C.B. Clarke
16	Pippali	*Piper longum* Linn.
17	Satawar	*Asparagus racemosus* Willd.
18	Patharchoor	*Coleus barbatus* (Willd.) Briq.)
19	Manjisth	*Rubia cordifolia* Linn.
20	Ammi majus	*Ammi majus* (L.) Koso-Pol
21	Silybum	*Silybum marianum* (L.) Gaertn.
22	Ritha	*Sapindus mukurossii Gaertn.*
23	Harad	*Terminalia chebula Retz.*
24	Brahmi/ Mandukparni	*Centella asiatica* L. Urban*/ Bacopa monnieri* Linn.
25	Lemongrass	*Cymbopogon flaxuosus* (Nees ex Steud.) W. Watson
26	Geranium	*Pelargonium graveolens* L'Her.
27	Rosemary	*Rosemarinus officinalis* L.
28	Chamomile	*Matricharia chamomilla* L. (Rydb)
29	Tagar	*Valeriana wallichii* DC.
30	Citronella	*Cymbopogon nardus* (L).Rendle.
31	Rose	Rosa sp.
32	Mint	*Mentha spicata L.*
33	Artemisia	*Artimisia annua L.*
34	Tejpat	*Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm.
35	Baheda	*Terminalia bellerica* (Gaertn.) Roxb.
36	Chiura	Madhuca butyracea (Roxb.) J.F.Macbr.
37	Amla	*Emblica officinalis* Gaertn.
38	Pachauli	*Pogostemon pachauli* (Blanco) Benth.

3.2. Medicinal and Aromatic Plants

Uttarakhand harbors over 700 species of medicinal plants of which 682 species are angiosperm, 12 species are gymnosperm and 7 speices are fern that are used in drug and pharmaceutical industries as well as also used in Ayurvedic, Unani and other traditional systems of medicine [8]. The state has already made significant strides for development of medicinal and aromatic plant (MAP) sector with a focus to facilitate economic development of the state by enhancing and modernizing production of medicinal plants; conserve natural heritage of the medicinal plants; safeguard local health traditions and knowledge on health care system; and to strengthen infrastructure, extension, market and R&D facilities for medicinal plant sector development. The Government intends to exploit this advantage. Medicinal plants and Aromatic plants are in great demand due to their unique curative properties. MAP is one of the fastest growing sectors in the world. India's growth rate of 22% is much higher than the global average (7%) in this sector [8]. Plant derived medicines are comparatively cheaper, and easily accessible. As more than 90% species are source from wild, the high market demand has propelled tremendous pressure on the natural resources [14]. Consequences of the loss of alpine plants biodiversity are harmful for ecosystem and inhabitant components. Growing demand for herbal products in the recent past has led to a quantum jump in volume of plant material traded globally. To conserve medicinal and aromatic plants, the Government of Uttarakhand has prioritized the species as given in Table 1 for mass scale cultivation along with providing subsidy on them.

Uttarakhand State is regularly working towards the strengthening of MAP sector so that it could be developed as an important asset of rural area development. In the coming year, state would be developed as an important herbal destination and Ayush Pradesh.

3.3. Agricultural Diversity

Agriculture is the main livelihood activity of the state. Of the total population, more than 75% people are depended on agriculture based activity. The traditional farming systems have close linkages with animal husbandry and forest ecosystem [15]. Majority of the farmers are marginal having only 0.68 hactares size land in fragmented form covering (85 percent of Uttarakhands total agriculture land) are largely rainfed whereas the valleys (covering 15 percent of the states agriculture area) are irrigated [16]. Women are the main workforce in performing agriculture based activites. In traditional agriculture, farmers grow 40 types of crops and cereals. The main crops are rice, wheat, maize, barley, barnyard millet, finger millet, buckwheat, nacked barley, hog millet, foxtail millet and pearl millet. The main grown vegetables are onion, potato, peas, pumpkin, gourd, cucumber, mustard, soybean, mat bean, black gram, green gram, cow pea, rice bean, amaranthus and okra. Potato is the important vegetable. Some tree species that yield fodder, fuelwood, fibre, fruits etc are maintained in agriculture fields. Wheat grows in highest percent (33.54%) in total sown area, followed by rice (23.51%), millets (12.6%) and vegetables (12.45%) [13]. State is having very suitable climate therefore some off season vegetables can be grown as a sustainable livelihood option.

3.4. Horticulture

The climate of Uttarakhand is suitable for growing different types of temperate, sub-tropical and tropical fruits. A total of 19 different types of fruits excluding the wild varieties are grown in the state. Among the fruits, mango, apple, citrus, litchi and guava are main fruits of the state. The temperate fruits such as apple, pear, peach, plum, apricot, cherry and walnut are grown at 1000 m-3000 m height [17]. The major problem with fruits is lack of market linkages, post harvesting technologies and their storage. Horticulture is one of critical sectors in the economy of the hilly state Uttarakhand. It provides much needed opportunity for diversification and increased employment in the state where the scope of high rate of growth in conventional agriculture is rather limited due to peculiar topography and majority of scattered and marginal holdings. Horticulture development can become an effective tool for accelerating development in the hilly areas as well as boosting the income of farmers beyond the subsistence level that they manage from traditional agricultural crops. Area under 11 horticultural crops can be increased particularly if cultivable wasteland and farms belonging to migrated people are utilized to grow these crops [18].

3.5. Floriculture

Floriculture is a grooming sector in the state as environment being suitable for growing different flowers. Floriculture can generate employment opportunity and enhance income of farmers. Farmers have started raising many flowers. They have substituted traditional farming for floriculture in the state. Exquisite varieties of flowers like carnation, lily, chrysanthemum, gladiolus, gerbera and Indian red roses that are in high demand in domestic as well as in European markets are produced in the state. Uttarakhand has emerged as the largest producer of Gerbera in the entire region of northern India. However, to promote the floriculture, government provides good quality seeds to the farmers apart from the necessary technical know-how.

Table 2. Ethnobotanical uses of various plant species.

S. No.	Ethnobotanical Uses	No. of Species
1	Wild Edibles used in beverages	20
2	Religious Plants	17
3	Plants used in arts and crafts	20
4	Spices and Condiments	13
5	Oil Yielding wild plants	37
6	Sacred Plant species	16
7	Species used in festivals	5
8	Bioprospecting	96
9	Timber	44
10	Social forestry	15

3.6. Ethnobotanical Plant Species in the State

There are about 318 plant species of ethnobotanical uses in the State which are used as condiments, spices, oil yielding, alcoholic and non-alcoholic beverages, in various religion and culture courses, arts and crafts, sacred

values, religious festivals, bioprospecting and miscellaneous purposes. Apart from this, there are 44 timber yielding species and 15 social forestry species in the state [6]. Ethnobotanical uses of various plant species has been given in Table 2 [4].

3.7. Faunal Diversity

A total of 4907 faunal species have been reported which include 3948 invertebrate and 959 vertebrate. Many endemic and threatened species of both are also found [19,20]. Some animals like Leopard, Langur, Himalayan black bear, kakar, goral etc. are found in sub alpine region. Whereas musk deer (Kastura Mrig), snow leopard, blue sheep, thar etc are inhabitants of high altitude [21]. Colorful bird's species e.g. Peacock, Kala Titar, Whistling thrush, Chakor, monal pheasant cheer pheasant, koklas pheasant etc. [22,23] have been reported from this region.

Table 3. Details of protected areas in Uttarakhand [23].

Name of the PA (district)	Year of Establishment	Area (km^2)	Flora	Fauna
Corbett NP (Nainital, Pauri Garhwal)	1936	520.80	Sal. Haldu, Pipal, Rohini and mango are common species.High banks and islands are dominated by *Dulbergia sissoo*.	Tiger, elephant, chital, sambar, nilgai, gharial, King Cobra, wild boar, hedgehog, Indian Pangolin, and nearly 600 sps of birds
Govind WLS (Uttarkasi)	1955	485.89	Rhododendron, Cedrus deodara, Quercus, Blue Pine, Walnut, Hazel chest nut	Blak beer, Brown beer, Snow leopard, Musk deer, sambhar, Jackal; 200 sp. of birds
Kedarnath WLS (Chamoli)	1972	975.24	Temperate, Alpine, Sub Alpine forest and Alpine moist scrub	Leopard, Musk Deer, Brown Beer, Jackal, Wild boar , 240 sp. of birds
Askot WLS (Pithoragarh)	1986	599.93	Kunj, kail, Kharsu, Fir, Bhojpatra, Darkunja, Raijal	Black bear, Brown bear, Snow leopard, Musk deer, and 227 sp. of birds
Binsar WLS (Almora)	1988	45.59	Pine and Oak forest	Leopard, Musk deer, Jackal, Barking deer and 166 bird species
Musoorie WLS (Dehradun)	1993	10.82	Moist temperate forest, Oak and S. alpine forest	Leopard, Black Beer, Goral, Barking Deer and Himalayan quail
Sonanadi WLS (Garhwal)	1987	301.18	Pine, Moist and Dry deciduous forest	Tiger, Leopard, Elephant, Barking Deer, Sloth Beer and Slender billed Vulture
Nanda Devi BR (Chamoli, Almora and Pithoragarh)	1988	5,860.69 km^2	600 species of angiosperms, 30 species of Pteridophyta, 76 wood species.	Bharal, Goral, Himalayan musk deer, ,Wild boar, Sambar, Snow leopard, Jungle cat, Brown bear, Common leopard, Himalayan leaf-nosed bat, Common giant flying squirrel., 546 bird species
Jhilmi Jheel CR (Haridwar)	2005	37.83	Grassland and Sal	Sambhar, Elephant, Neel Gai , Panther, 160 sp. of birds,Spotted deer, Neel gai
Valley of Flowers NP (Chamoli)	1982	87.50	*Duthiea bromoides, Herminium joshephii, Lycopodium selago, Salix calyculata* and *Saussurea atkinsonii*.	Mammals: 13 species Birds: 82 species
Rajaji NP (Dehradun, Hardwar, Pauri Garhwal)	1983	820.42	Sal, Acacia catechu, Dalbergia sissoo, Gular, Haldu, Jhingan, Tun, Gutel and many species of shrubs and herbs	Tiger, Common leopard, Jungle cat, Leopard cat, Barking deer, Nilgai, Goral, Hog deer, Wild boar, Sambar, Sloth bear, Asiatic black bear, Common palm civet. Birds 312 species
Gangotri NP (Uttarkashi)	1989	2200.00	Chirpine, deodar, Fir, spruce, oak and Rhododendron	Asiatic Black bear, Brown bear, Leopard, Snow leopard, Barking deer, Bharal, Goral, Himalayan musk deer, Himalayan tahr, Wild boar, Sambar, Serow, Jackal, Indian porcupine, Rhesus macaque, Common langur, Stone (Beech) marten, Birds over 100 species
Govind NP (Uttarkashi)	1990	472.08	*Pine,Cedar, Oak , maples, walnut, horse chest nut and Rhododendron* with other broad leaved species	Asiatic black bear, Brown bear, Leopard, Snow leopard, Barking deer, Bharal, Goral, Himalayan Thar, Himalayan musk deer, Wild boar, Sambar, Serow, Jackal, Indian porcupine, Rhesus macaque, Himalayan weasel, Birds- 120 species

3.8. Major Initiatives for conservation of Biodiversity

Biodiversity is very important for the wellbeing of particular area. Survival of many people is totally dependent on bio-resources. Biodiversity has been affected due to large scale construction, over-exploitaion and disasters. Unfortunately few species have been loss from their natural stand. For the conservation of biodiversity world over many initiatives have been taken by the government and tried to aware people about its usefulness. Uttarakhand state has also taken many important initiatives to conserve the biodiversity by developing protected area network, national parks, wild life centuries, Medicinal Plant Conservation Areas (MPCAS), herbal gardens, arboretums, parks and zoos [21]. Uttarakhand 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 and constituting 13.68% of the state's geographic area [23,24]. According to the repost of FSI, the details of protected areas of Uttarakhand have been summarized in Table 3 as on 01.09.2011.

3.9. Biodiversity Conservation Policies

Most of the policies for the conservation of Biodiversity, which have been prepared for Indian context, are applicable in Uttarakhand state. In this direction, National Board for Wildlife (NBWL) provides the policy framework for wildlife conservation in the country. The wild life conservation through people's participation has been described in National Wildlife Action Plan 2002-2016. In this regard, the execution of Wildlife (Protection)

Act 1972, is complemented by other Acts such as Indian Forest Act 1927, Forest (Conservation) Act 1980, Environment (Protection) Act 1986 and Biological Diversity Act, 2002 as well as by the Scheduled Tribes and other traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 [24]. In the state, Forest Department works as a nodal agency to apply different biodiversity forest conservation measures of central schemes such as implementation of Integrated Development of Wildlife Habitats, Project Tiger, Project Elephant, etc. Due to the prosperity of biodiversity of Uttarakhand state, several significant steps have been employed and established by central as well as by state government as given below:

1. First National Park in the Asian Mainland (Corbett National Park)
2. Govind Wildlife Sanctuary
3. Kedarnath Wildlife Sanctuary
4. Valley of Flowers National Park
5. Rajaji National Park
6. Project Tiger in Corbett National Park launched
7. Nanda Devi Biosphere Reserve (India's second Biosphere Reserve)
8. Asan Wetland and Jhilmiltal conservation reserves
9. Uttarakhand Biodiversity Act, 2002
10. Establishment of State Medicinal Plant Board (SMPB)
11. Wild Life Advisory Board
12. Medicinal Plant Conservation Areas (MPCAs)
13. Establishment of Anti Poaching unit

4. Discussion and Conclusion

Uttarakhand falls in Central Himalaya which exhibits about 7000 species of plants and 500 species of fauna. Contribution of floral diversity is 31% of total floral density of India whereas fauna contributes just 1.58% of the total faunal density of the country. Considering the importance of the biodiversity in the Central Himalaya, it has been recommended to conserve all the sectors that are directly or indirectly related with the life of communities residing in mountaineous region. Forest diversity is the main source of livelihood of the people living in Central Himalaya. For the past few decades, due to population pressure and overexploitaion, forest density have reduced, which is a serious problem. Though, there are many policies and planning to conserve the forest but there is need to generate mass awareness and capacity building of communities. Proper planning is required to conserve the forest resources. Medicinal and Aromatic Plant (MAP) is a growing sector and Uttarakhand has tremendous potential in it as it harbors 700 species. World Health Organisation (WHO) estimates that 80% of the human populations in the developing countries rely on traditional medicines, mostly plant drugs, for their primary health care needs. The development of agro-production techniques for certain species of MAPs can help to meet the requirement of raw material for commercial use and reduce the pressure on the existing populations in natural habitats. Value addition of different natural resources can upgrade the socioeconomic staus of communities and can become an important livelihood option. This will help them sustain their livelihoods, and at the same time preserving the natural biodiversity as well as culture and quality of life. For this, strong institutional linkages are to be developed along with the capacity building of local people. Sustainable collection and utilization of wild MAPs is a major concern. Therefore, cultivation of selected species is highly demanding and deserves immediate action. State is having very suitable climate for the fruits and vegetables. Therefore to maintain the agriculture and horticulture diversity, some off season vegetables and commercial fruit species can be promoted as sustainable livelihood option. Apart from this, there are many ethnobotanical importance plant species and faunal diversity in the state. Uttarakhand state has taken many important initiatives to conserve the biodiversity by developing protected area network, Medicinal Plant Conservation Areas (MPCAS), national parks, wild life centuries, herbal gardens, arboretums, parks and zoos. Many Policies have also been developed for the conservation of biodiversity in the Cetral Himalaya.

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