

CHAPTER – 1

INTRODUCTION

1.1. Brief Background

The concept of biodiversity and its conservation was realised with environment and development programme at Rio de Janeiro in June 1992. The animals and plants are distributed and adapted to enormous eco- and geo-diversity. In nature man and his livestock derives its needs from biodiversity and its products. Our clean environment is also dependent on the biodiversity and carbon cycle. The occurrence and distribution of plants and animals are related with respect to its environment. The wild plants and animals are suitably modified and adapted in response to environment and are in the process of continuous evolution. All the domesticated varieties of domesticated animals and plants have been derived from the wild stock. These bio-resources are the wealth of the country, which require to be conserved for sustainable use and needs of all people who are traditionally dependent on them.

The National Biodiversity Strategy and Action Plan (NBSAP) is proposed to be developed through a “participatory planning process involving all major stakeholders”, as is stressed in the original Project Document signed by the Government of India and the United Nations Development Programme (UNDP). This campaign can be categorised into three basic elements:

- **Saving Biodiversity:** Saving biodiversity means taking steps to protect genes, species, habitats and ecosystems.
- **Studying Biodiversity:** Studying biodiversity means documenting its composition, distribution, structure, function, understanding the roles and function of genes, species and ecosystems.
- **Using Biodiversity Sustainably and Equitably:** Using biodiversity sustainably and equitably means husbanding biological resources so that they last indefinitely,

making sure that biodiversity is used to improve the human condition, and seeing that these resources are shared equitably.

As a part of National Biodiversity Strategy and Action Plan (NBSAP), an extensive exercise was undertaken to develop a Strategy and Action Plan (SAP) for the Shiwalik Eco-region that cuts across the states of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttar Pradesh and Uttaranchal, and the union territory of Chandigarh. In the geological past, the Shiwalik region harboured several species of African mammals as evidenced by fossil records of elephants, dinotheres, primitive trilophodonts, Hipparian horse and antelopes. The Shiwaliks are also considered as one of the endemic centres (MOEF, 1999) for the biodiversity.

The present exercise deals with various aspects of the biodiversity of highly fragile Shiwalik Eco-region. It reviews the present status of biodiversity and different ecosystems in the area. Several gaps are identified in existing biodiversity related programmes.

1.2. Scope

The document covers the following biodiversity related areas:

- (i) Wild biodiversity – Wild animal diversity from microscopic Protozoa to large mammals; Wild plant diversity (including medicinal plants); different ecosystems.
- (ii) Domesticated biodiversity.
- (iii) Natural aquatic ecosystems.
- (iv) Education, awareness and training.

1.3. Objectives

- (i) Assess the existing status bio-resources (wild biodiversity, domesticated biodiversity, and ecosystem biodiversity) of entire Shiwalik Eco-region.

- (ii) Evaluate threats to animal and plant species in the area with respect to destruction of wild habitat and effects of pollution.
- (iii) Identify conservation and management measures.
- (iv) Promote sustainable use of bio-resources.
- (v) Strengthen ongoing biodiversity conservation measures.
- (vi) Promote taxonomic and other studies on all wild animals and plants, especially lower animals and plants.
- (vii) Create a single authority for coordination of biodiversity conservation efforts among all states and union territory under the Shiwalik Eco-region.
- (viii) Create a centre for biodiversity database for all actors in the Shiwalik Eco-region.
- (ix) Active participation of all stakeholders, especially women, poorer sections of society, farmers, etc. in biodiversity conservation programme.
- (x) Promote education, awareness and training for various sections of the society.

1.4. Methodology

1.4.1. Formation of Steering Committee

For the preparation of SAP for Shiwalik Eco-region, a steering committee was formed with renowned persons from various scientific organisations like Panjab University, Jammu University, Dr. Y.S. Parmar University of Horticulture & Forestry, H.P. Krishi Vishva Vidhayalaya, Indian Agricultural Research Institute, Botanical Survey of India (Dehra Dun), Zoological Survey of India (Solan & Dehra Dun), Regional Research Laboratory (Jammu), and Department of Forest & Wild Life of all states under Shiwalik region. Some NGOs of the area, including women, were also included in the steering Committee.

Two meetings of the steering committee were organised at Chandigarh and Jammu on 29.1.2001 and 1.6.2001 respectively. The following issues were considered:

- Participants gave an overall view of their studies and contributions on the biodiversity of their areas.
- General perception among all participants was that the present biodiversity conservation efforts have not yielded desired results, and common people are unnecessarily harassed.

1.4.2. Formation of Coordination Committees

To assess the present state of biodiversity, the following coordination committees were constituted:

- Wild animal diversity.
- Wild plant diversity.
- Medicinal plant diversity.
- Education, awareness and training.

1.4.3. Public Contact Programmes

Three public contact programmes were organised at Pong Dam, Solan and Jawalaji for people's knowledge on uses of common medicinal plants and animals around their surroundings. Lectures were also delivered for awareness on various aspects of biodiversity conservation.

1.4.4. Training Programme for In-service Teachers

Two biodiversity related training programmes were organised for secondary school teachers in collaboration with the H. P. State Science & Technology and Department of Education. A total of 20 lectures were delivered on the role of fauna in natural ecosystems.

1.4.5. Production of Publicity Material

Two posters and ten brochures on the relationship of fauna and flora with the mankind in the Shiwalik Eco-region were produced and distributed among various schools, foresters and common people. A pictorial booklet for easy identification of some water birds of Pong dam was also prepared and released as part of biodiversity awareness drive.

CHAPTER – 2

PROFILE OF AREA

2.1. Geographical Profile

The term ‘Sivalik’ (spelt as Shiwalik in this document) was first coined by Caltley (Mittal et.al.,2000) for the sedimentary sequences between the rivers Ganga and Yamuna near Haridwar in Uttaranchal. According to Hindu mythology, the Himalayas are considered as the abode of Lord Shiva and the name ‘Shiwalik’ for the outer Himalayas was derived from the tresses of the Lord. At present the Shiwaliks include the entire southwestern foothills of the Himalayas from Indus river on the northwest to the river Brahmaputra river on the northeast.

2.1.1. Location

The Shiwalik Eco-region extends from 29°-33° N latitude to 74°-80.5° E longitude. These ranges represent the southernmost zone of about 8 – 40 km width and about 800 km length of the Himalaya. In the north, these hills fall in the districts of Udhampur, Kathua, and Jammu, ultimately merging with Reasi and Poonch districts of Jammu & Kashmir. In the northeast, they are in the districts of Chamba, Kangra, Bilaspur, Una, Hamirpur, Solan and Sirmour in Himachal Pradesh, Panchkula and Yamuna Nagar in Haryana, Dehra Dun, Haridwar and Udham Singh Nagar in Uttaranchal, Saharanpur and Rampur in Uttaranchal Pradesh. State-wise area of Shiwaliks in northwest states is given in Table-1. Maximum area of 1.14 million hectares is in Himachal Pradesh.

Table-1 Area of Shiwaliks in northwest States

Source : Sidhu et. al. (2000)

Name of the State	Approximate area (Million Hectres)
Jammu & Kashmir	0.80
Punjab	0.14
Himachal Pradesh	1.14
Haryana including Union Territory Chandigarh	0.06
Uttaranchal and UttarPradesh	0.86
Total :	3.00s

2.1.2. Topography

The Shiwalik ranges or the outer Himalayas rise from the plains of India as low hills and go on attaining height till reach an altitude of 1000m. These hills gradually rise from the Indo-Gangetic plains with a gentle slope of 3-4 degrees till they touch a rugged topography and bare steep slopes. In this tract, some hill ranges run roughly parallel to each other for long distances and converge at places, meet and diverge again giving rise to small longitudinal spindle-shaped plateaus or *duns* between them. With torrential rainfall during monsoon periods, the area is subject to soil erosion hazards due to undulating topography, poor vegetation cover and coarse medium texture of sedimentary materials. **The Kashmir Shiwalik** is represented in the Jammu hills which extends from the river Jhelum to the Ravi. Jammu town stands on a Shiwalik hill, overlooking the Tawi river. These hills are very much dissected and synclinal valleys often form ridge crests. They are fringed in the south by a belt of stony arid surface called *Kandi*, which does not have enough surface water for irrigation.

Based on weathering and erosion, two major landforms are of common occurrence in the area besides the hills. These are *penneplains* comprising of gently rolling worn out hill lands and *piedmont plains* that are fan shaped deposits at the foot of hills brought about by streams.

Major perennial Himalayan rivers like Chenab, Ravi, Beas, Sutlej, Yamuna and Ganga drains the area. These hills are also drained through a number of crisscrossed perennial shallow or dry nallaha, which are locally designated as khuds or choes.

2.1.3. Geology

The Shiwalik Eco-region comprises of rocks that fall under Cenozoic Era and belongs to Middle-Miocene, Pliocene and Lower Pleistocene period. This system of rocks is considered to be one of the largest storehouses of mammalian remains and other vertebrate fossils. The study of these rocks has made it possible for the geo-scientists to probe into the mysteries of evolution of life, climate and physiography of these periods. The era of Shiwalik system of rocks is also called the Age of Mammals, as the system contains considerable mammalian fossils. The fossils comprise of elephants, dinotheres and primitive trilophodonts, which fed on succulent herbage and were water love types, which are characteristic of warm and humid lowlands. The horse Hipparian is thought to have flourished in a savannah or swamp type of condition prevalent in the geological history of the Shiwaliks. The fossils of antelope suggest prairies, steppes or desert conditions in the past.

The Shiwalik ranges mainly comprise of soft Tertiary sediments – sandstone, siltstone, shale and clays, and are readily subject to mechanical disintegration. These ranges, being in the front, also face the full forces of the monsoon currents and have torrential rains. Hence mass-wasting is very common in these areas and all along we see huge landslides or scars of old landslides.

Major perennial Himalayan rivers like Chenab, Ravi, Beas, Sutlej, Yamuna and Ganga drain the area. These hills are also drained through a number of crisscrossed perennial shallow or dry nallahas, which are locally designated as *khads* or *choes*.

2.1.4. Physiography

The vegetation along the foothills of the Shiwalik hills comprises of thorny bushes e.g. *Acacia-Zizyphus*. *Shorea robusta* assumes prominence in the sandy rocks of the Shiwaliks. Freshwater swamp forests of *Bischofia javanica*, *Salix tetrasperma*, *Pyrus pashia* and *Carallia brachiata* are found in and around Dehra Dun. Major forests of Shiwaliks are classified as follows:

- i) *Acacia* forests;
- ii) *Bauhinia* forests;
- iii) *Dodonaea* forests;
- iv) Mixed semi-deciduous forests;
- v) Sal (*Shorea robusta*) forests;
- vi) Chir (*Pinus roxburghi*) forests.

The climate of the Shiwaliks is warm sub-tropical. It is very hot in summer and markedly cold in winter. The summer season usually starts from April and lasts up to June. The weather is very hot during this period and only dust and thunderstorms, which are sometimes accompanied by light showers of rains, relieve its intensity. The rainy season (July to September) commences with the break of the southwest monsoon and is regarded as the most significant climatologically event from agricultural point of view. The months of October and November in which the weather generally remains dry but the temperature falls down, and are the most pleasant months of the year. The cold or winter season begins from December and ends to March.

Rainfall and temperature data for some important locations in the in the Shiwalik Eco-region are given in Table. 2. &3.

Table – 2. Temperature conditions of some Shiwalik Eco-region**Stations. I = Mean maximum; II = Mean minimum (°C)**

Month	Dehra Dun		Bilaspur		Nurpur		Jammu	
	I	II	I	II	I	II	I	II
January	19.1	6.8	18.2	5.9	17.8	5.8	18.5	8.9
February	20.8	8.0	19.5	8.1	18.2	7.9	20.3	10.8
March	26.2	12.5	24.3	12.9	23.2	11.6	26.0	15.3
April	32.4	16.8	32.4	12.8	31.9	12.4	32.0	20.5
May	35.9	21.0	38.2	19.3	35.3	18.2	37.8	26.2
June	34.4	23.4	35.3	20.2	35.9	20.2	40.0	25.3
July	30.2	23.2	32.0	20.2	30.1	18.1	35.9	23.8
August	29.2	22.8	30.1	18.1	29.8	17.5	33.1	23.2
September	29.4	20.2	30.1	18.0	29.8	17.3	33.1	20.0
October	28.3	15.7	28.0	14.9	27.5	13.3	30.9	19.6
November	24.5	9.6	24.9	10.1	24.0	9.9	25.6	13.3
December	21.0	7.0	20.1	6.8	19.7	6.3	20.0	8.2

Table – 3. Rainfall conditions of some Shiwalik Eco-region stations**(in mm)**

Month	Dehra Dun	Bilaspur	Nurpur	Jammu
January	58	53	43	58
February	67	62	57	62
March	33	27	21	24
April	18	15	11	13
May	38	20	18	20
June	216	232	212	222
July	663	620	631	632

August	727	700	699	701
September	282	266	262	255
October	32	37	32	30
November	9	8	8	8
December	25	24	23	30

2.2. Socio-economic Profile

Major ethnic groups in this area are Gaddis, Gujjars, Choohamar, Banjare, Balmikis, Julhas, Bazigaars, etc. Majority of people is agriculturists, graziers and filed labourers. Other professions include fishing, sericulture, apiculture, spinning, etc. Some persons are also engaged in industry, mining, construction, forestry and horticultural produce, traditional and folk medicine, jewelry, etc. Economically, most of the population is just at or below subsistence level. The rural population uses firewood to meet bulk of their energy requirements. Cattle-dung finds use more as a manure, than as a source of energy. Timber is needed basically for house building; making agricultural implements, etc.

2.3. Political & Administrative Profile

2.3.1.1. Political

All the states in the Shivalik region have democratically elected governments. Rural areas have their own Panchayats for settling their day to day issues. Each district has Mahilla Mandals and Women's Welfare Organisations. Several religious organisations are playing an important role in socio-cultural and religious activities relating to biodiversity conservation through out the Shivalik region.

2.3.2. Administrative:

Each state in the Shiwalik Eco-region is divided into districts for better administration. The general administration and revenue matters in a district are under the charge of District Collector. Various departments, related to biodiversity, are administered by Principal Secretaries in each state. These are as follows :

2.3.2.1. Jammu & Kashmir

Department of Science & Technology, Environment, Social Forestry, Forests and Wild life, Agriculture, Horticulture, Sericulture, Animal Husbandary, Fisheries, Public Works, Irrigation and Mining
 Pollution Control Board
 State Forest Research Institute
 Regional Research Laboratory (CSIR)
 Insect Pest Management (Ministry of Agriculture)
 Department of Biosciences Jammu University
 Department of Environmental Sciences Jammu University
 Department of Botany and Zoology Kashmir University, Srinagar

2.3.2.2. Punjab

Department of Science & Technology, Environment, Social Forestry, Forests and Wild life, Agriculture, Horticulture, Sericulture, Animal Husbandary, Fisheries, Public Works, Irrigation and Mining
 Pollution Control Board
 Bhakra Beas Management Board
 Sugarcane Research Institute
 Insect Pest Management (Ministry of Agriculture)
 Leather Research Institute
 Panjab Agriculture University, Ludhiana, Department of Botany and Zoology
 Panjabi University Patiala, Department of Zoology and Botany

Panjab University, Department of Zoology and Botany
 Guru Nanak Dev University, Department of Biosciences

2.3.2.4. Himachal Pradesh

Department of Science & Technology, Environment, Social Forestry, Forests and
 Wild life, Agriculture, Horticulture, Sericulture, Animal Husbandary,
 Fisheries, Public Works, Irrigation and Mining
 Pollution Control Board
 Insect Pest Management (Ministry of Agriculture)
 Himachal Agriculture University, Palampur
 Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan
 Himachal Pradesh University, Department of Biosciences
 Potato Research Institute, Kufri, Shimla
 G.B.Pant Institute of Himalayan Ecology, Kullu
 Institute of Himalayan Bioresources, Palampur
 Coniferous Research Institute
 High Altitude Zoology Field Station, Zoological Survey of India, Solan
 National Institute of Plant Genetic Resources, Shimla

2.3.2.4. Haryana

Department of Environment, Forestry, Forests and Wild life, Agriculture,
 Horticulture, Sericulture, Animal Husbandary, Fisheries, Public Works, Irrigation
 and Mining
 Pollution Control Board
 Bhakra Beas Management Board
 C.C.S. Haryana Agriculture University, Hissar
 Kurukshetra University, Department of Zoology and Botany, Kurukshetra
 M.D. University, Department of Biosciences, Rohtak
 Central Inland Fisheries, Karnal
 National Dairy Development, Karnal

Central Buffalo Research Institute ,Hissar

Central Soil Research Institute

2.3.2.5 Uttarakhand

Department of Science & Technology, Environment, Social Forestry, Forests and
Wild life, Agriculture, Horticulture, Sericulture, Animal Husbandary,
Fisheries,Public Works, Irrigation and Mining

Pollution Control Board

Gharwal Vikas Mandal, DehraDun

Northern Regional Station,Zoological Survey of India,DehraDun

Northern Regional Station, Botanical Survey of India, DehraDun

Forest Research Institute, DehraDun

Wild Life Institute of India, DehraDun

Central Soil Conservation, DehraDun

Indian Institute of Remote Sensing, DehraDun

G.B.Pant Institute of Himalayan Ecology,Pant Nagar

G.B. Pant University of Agriculture,Pant Nagar

Department of Botany and Zoology,SriNagar

Gurukul Kangri University,Haridwar

Central Silk Board, Prem Nagar, DehraDun

2.3.2.6. Uttar Pradesh

Department of Science & Technology, Environment, Social Forestry, Forests and
Wild life, Agriculture, Horticulture, Sericulture, Animal Husbandary,
Fisheries,Public Works, Irrigation and Mining

Pollution Control Board

Central Drug Institute, Luknow

Sugarcane Research Institute

Insect Pest Management (Ministry of Agriculture)
 National Botanical garden
 Lukhnow University, Department of Botany and Zoology
 Meerut University, Department of Zoology and Botany
 Central Fisheries Genetic Resources, Lukhnow
 Department of Agricultural Sciences, Banaras
 Muslim University, Aligarh, Department of zoology and Botany, Aligarh

2.3,2.7. Union Territory, Chandigarh

Department of , Forests and wild life, Agriculture, Horticulture,
 Fisheries, Public Works, Irrigation and Mining
 Pollution Control Board
 Bhakra Beas Management Board
 Panjab University, Department of Zoology and Botany
 Central Soil and Water Conservation Research & Training Institute

2.4. Ecological Profile

It is well known that the Himalayan Mountain chain is the result of intercontinental collision of Eurasian and the Indian plates. Numerous streams and streamlets draining the newly up heaved Himalayan region carried the products of incomplete mechanical fragmentation and after a short fluvial transport debouched the load in the basin that served as seat of the present Shiwalik belt (Choudhari,2000). In time and space, these sediments have given rise to several kinds of soil that have been variously classified by Sidhu et.al.(2000). Majority of these soils (67%) are loamy which include coarse and fine-loamy families followed by loamy-skeletal(28%),sandy-skeletal (1.0% and sandy (0.7%).

The Shiwalik hills were once covered with dense forests replete with rich and diverse biodiversity in near past (before middle of 18th Century). Unrestricted felling and overgrazing during the last 200 years or so have played havoc with natural vegetation in the area. Eroded ravines and barren slopes now characterise most of the Shiwalik hills. The area, once dotted with perennial springs and streams,is today represented as a land of ever

widening and deepening ferocious torrents, locally known as 'Choes' with high drainage density.

During the rainy season, excessive debris loads from bare and eroded hills are carried into hill streams down below. The coarse fractions of the debris get deposited in the water course in the form of gravel-isolated islands once the stream reaches the milder slopes in the valley. Reduced stream slopes cause considerable reduction in the carrying capacity of the streams. Flow tends to migrate laterally overstepping or undermining the banks that are often low and illdefined. This has led to encroachment of the streams into adjacent agricultural, forest and horticulture lands throughout the Shiwalik Eco-region. .

With the success of Sukhomajri project under watershed management Programme, began the era of water harvesting dams in the Shiwalik in eighties. As a result, over 200 such water harvesting dams in Haryana, Panjab and Himachal Pradesh have so far been constructed (Sikka,2000). These earthen dams are 6-16 m high with catchment upto 190 ha, storage capacity 60 ha-m and a variable command area (2-260 ha). Development of water resources locally initiated other developmental activities around this motivating catalyst. Recently, attempts have also been initiated to harvest perennial flow in watersheds, [particularly in Shiwalik districts of RoopNagar and Hoshiarpur in Punjab, by constructing sub surface dams/barriers across the streams. Significant ecological recovery has been made in the areas under water harvesting and watershed management programmes.

The land use of the region has been influenced by the nature of terrain and diversity of climate. Agriculture has greatly influenced the life of inhabitants and general ecology of the area. Agricultural land per head is very meager. Farming has been very much handicapped because of small and scattered holdings and limited irrigation. Most of the agriculture is dependent on rain fall. Agricultural production is not commensurate with the amount of labour put in. On whatever little agricultural land the inhabitants of the Shiwalik possess, they grow variety of crops, both kharif and rabi although on a limited scale. For example, three major crops, viz., maize, rice and wheat are grown in the Kangra Shiwaliks (Himachal Pradesh). The local varieties, which were being grown, had low yield potential and were less responsive to chemical fertilizers but because of sopecific quality characteristics the people of the area have a liking for them and they are still being grown in some limited pockets. The

present spread of high yielding varieties eg. S-308, VL-421 and VL-616 in wheat; Himalaya-2, Himdhan and China-988 in rice; Him-123 and Parvati in maize have covered 80% to 90% of the area (Kaul et.al.1993). There has been an increase in the cultivated areas also in Kangra Shiwaliks during the last few years. The area under maize has increases by 13.9% while in wheat the increase is 19.7%. However, the area under rice crop has decreased by 2.6%. Horticulture crops like oranges, kinnows and mangoes are also grown at suitable places.

Despite various steps taken for ecological restoration of the Shiwaliks, large tracts are still highly eroded and degraded. The magnitude of the problem is not evident, as there are not enough studies in its totality. But there are plenty of disturbing evidences to show that the onslaught of modern growth over the years is leading to increasing subsidence, exhausted soil, rapid loss of run-off water and heavy siltation and eutrophication of lakes in the region. Some of the consequences of the above are silting of reservoirs and riverbeds and frequent floods both in the flat areas of the Shiwaliks and in the adjoining Indo-Gangetic plains. There is also evidence of migration of people from several pockets where soil do not yield enough for sustenance. Further, there are hints of climatic change, perhaps leading to desertification.

The developmental activities have greatly impaired the water resources. The rapid urbanization, industrialization, introduction of new canals for irrigation, installation of hydroelectric power stations, etc. has led to the excessive exploitation of water resources. Being a backward area, there are several incentives for setting up industries in the Shiwaliks. The entire belt of Shiwaliks, adjacent to the plains, is now dotted with brick kilns and stone crushing units that are the source of air and other types of pollution. As a result, the natural land scape of these hills is fast changing with the increased demand for the construction of housing colonies for the workers and others. With the rise in human population, there is an appreciable increase in demand for agriculture and horticulture land that is being met under land reclamation programme.

The construction of roads has made accessible remote areas, has led to increased urbanization. Impact of urbanization is felt through the Shiwaliks. With the proposed development of water resources, the process of urbanization is expected to gain momentum.

There is a danger that increased urbanization may lead to creation of infrastructure for human settlement and encroachment on natural habitats, which are already fragile.

CHAPTER – 3

CURRENT (KNOWN) RANGE AND STATUS OF BIODIVERSITY

3.1. Natural Ecosystems

3.1.1. Forests

3.1.1.1. Forests and its vegetation

For the sake of traditional right system for the rural population and administration convenience, the forest management in the whole Shiwalik region from Jammu eastward to Punjab, Himachal Pradesh, Haryana, Uttaranchal, and Uttar Pradesh is divided into three categories. These are *State Govt. Forests* (including reserve forests), *National Parks* (including Wildlife Sanctuaries) and *Village Community Forests* (including Van-Panchayat Forests). There are two National Parks in the Shiwalik region of Uttaranchal and U.P.

Sub-tropical evergreen forests of olives (*Olea* sp.) once widespread in the lower hot valleys of Jammu and Himachal Pradesh are unprotected. It is probable that all natural forest has been cleared. Survey should try and identify remnant patches which could develop with protection.

The forest vegetation of the whole Shiwalik region has been divided into deciduous and semi-deciduous forests.

3.1.1.2. Deciduous Forests

The deciduous riparian forests are generally found on south facing hill slopes or in lower valleys, along the river and streambeds upto 500 m elevation. The dominant tree species are *Acacia catechu*, *Acacia nilotica* (naturalised), *Dalbergia sissoo*, *Mallotus philippensis* with under growth of *Pogostemone benghalensis*, *Muraya koenigii*, *Carissa opaca*, *Lantana camara*, etc. The deciduous miscellaneous forests are also present in ravines. *Mallotus philippensis* is the dominant species, associated with the *Bombax ceiba*, *Adina cordifolia*, *Cassia fistula*, *Albizia lebbek* etc. with shrubby undergrowth of *Ziziphus mauritiana*,

Clerodendrum viscosum, *Adhatoda zeylanica*, *Carissa opaca* or *Carissa spinarum* and *Lantana camara* etc. are the common taxa.

3.1.1.3. Semi-deciduous Forests

These mixed forests are distributed above 500 m, on warmer and generally north facing slopes. The characteristic vegetation of these forests comprises of *Shorea robusta* (sal) and *Pinus roxburghii* (chir-pine). They are associated with a large number of other species, such as *Lannea coromandalica*, *Anogeissus latifolia*, *Syzygium cumini*, *Terminalia alata*, *Mitragyna parviflora*, *Windlandia exserta* and *Mallotus philippensis*, etc. along with various shrubs like *Desmodium, indigofera*, *Woodfordia fruticosa*, *Murraya koeniggi*, *Callicarpa macrophylla*, *Filemingia spp.* and *Phoenix himilis*.

Several plant species are frequently grown in around the rural area, especially along the agricultural lands, for food, fodder, fuel and timber. The important of them are *Boehmeria rugulosa*, *Ficus auriculata*, *Ficus racemosa*, *Grewia optiva*, *Celtis australis*, *Toona ciliata*, *Bauhinia variegata*, *Bauhinia semla*, *Bauhinia racemosa*, *Pyrus pashia*, *Ougeiniaoo jeinensis*, etc.

3.1.2. Grasslands/Pastures

The entire landscape of the Shiwalik Eco-region is dotted with vast grasslands and pastures. These habitats provide nutrient rich forage for grazing livestock. These grasslands are mostly manmade, being the result of deforestation. Faunal diversity of the pastures is characterised by a host of insect species, such as crickets (*Gryllus*), grasshoppers (*Oxya*, *Acrida*, *Aulacobothrus*, *Bryodema*), butterflies (*Lycaena*, *Tarcus*, *Colias*, *Catopsila*, *Pieris*), beetles (Curculionidae, Bruchidae, Chrysomelidae), etc. Common vertebrates in this ecosystem comprise of rats (*Rattus rattoides*), hares (*Lepus nigricollis*), and various kinds of birds and reptiles. Pastures in the area also provide habitats for many wild ungulates, such as sambar, blue bull (nilgai), spotted deer, barking deer and goral. A sharp increase in the population of grazing livestock has exerted an intense pressure on the biodiversity of pastures in Himachal Pradesh.

3.1.3. Aquatic Ecosystem and Biodiversity

3.1.3.1. Rivers and Streams

The aquatic ecosystem of Shiwalik Hills is a very important ecosystem with a network of Himalayan perennial rivers, namely Chenab, Ravi, Beas, Sutlej, Yamuna and Ganga. An intricate network of torrential streams drain into these river systems. Top loose and fragile fertile soil of Shiwalik hills is washed into these rivers during the rainy season. These rivers and hill streams harbour a variety of animals and plants. The animal and plant communities are adapted in commensurating with the need of the environment. The hill streams have increasingly being used to run the *Pan-Chakkis* since the ages.

River valley projects bring considerable changes, both good and bad, in the ecology of rivers and surrounding areas. In the Shiwalik region, big dams have been constructed at Thein on river Ravi, Bhakhra on river Sutlej and Pong on river Beas, resulting in the formation of very large reservoirs and reduced water flow in the downstream of these rivers. *Tor putitora* or the mahseer is an important commercial fish in the rivers of the area. Mahseer migrates from the main rivers to the tributaries for breeding in monsoon months and descends back before the onset of winter. Besides destructive methods of fishing like dynamiting and poisoning, dams and barrages have been implicated in the decline of mahseer fishery in the Shiwaliks.

The poor farmers have lost their fertile lands by submergence of their agricultural fields in large reservoirs. High humidity conditions have provided ideal conditions for the proliferation insects pests of crops. Alteration of aquatic habitats has put a great stress on several animals and plant communities. Prior to the construction of dams and irrigation canals the area of the outer Shiwalik was dry and ground water resources were not explored. With the construction of dams and irrigation canals there is a rise in the water table and water is logged in various small ponds and puddles where various types of insects (aquatic beetles, bugs, etc.), Mollusca and crustaceans breed.

The entire area is also drained by thousands of seasonal streams. During the monsoons, these cause widespread floods. Most important seasonal rivulets are Gaggar and Markanda. These seasonal streams and rivulets afford a congenial environment for a variety of plants and animals.

Wetlands: There are several natural and manmade wetlands like Mansar, Suransar, Thein Dam, Pong Dam, Gobind Sagar Dam, Sukhna Lake, Asan Barrage etc. These wetlands

support a variety of animals and plants especially more than 2 Lakhs migratory birds. They serve as most productive life support system and the habitat for birds, fish and rich diversity of invertebrates. These wetland of Shiwalik harbour great faunal diversity from protozoa to mammals. The wetlands are subjected to several anthropogenic pressures as a result we are losing the various diversity components.

3.1.4. Lake and Reservoirs

The Shiwalik Eco-region is bestowed with some natural and freshwater lakes and a few large manmade reservoirs and small lakes. They serve as important support systems and as habitats for birds, fishes and other aquatic life. Important natural lakes in the area are Mansar, Suransar, Renuka and Saketi. Some large reservoirs have been formed due to damming of rivers, e.g. Thein on river Ravi, Pong on river Beas, and Gobind Sagar on river Sutlej. Manmade lakes are Sukhan, Ropar and Asan. Renuka Lake, Ropar Lake, Sukhna Lake, Maharana Pratap Sagar (Pong Dam), and Gobind Sagar reservoirs have been declared as wetlands, which are biologically most productive. Among these Renuka, Sukhna, Ropar and Pong are of national importance.

Renuka wetland exhibits great faunal diversity as it is well protected because of its remoteness and location amid a wildlife sanctuary of the same name. Studies conducted in 1992-93 by the scientists of High Altitude Zoology Field Station of Zoological Survey of India at Solan show an existence of 427 faunal species in Renuka wetland and surrounding marginal areas of the sanctuary (Table). These belong to different groups: mammals (24), birds (103), reptiles (14), amphibians (9) and fishes (14) among vertebrates; insects (209) and other invertebrates (49). Despite many favourable conditions for the development of rich fauna, the wetland is facing the problems of organic pollution and eutrication (Singh et al., 1987). Interestingly, Renuka wetland does not attract waterfowl since it is very narrow with a maximum width of 204m. All waterfowl and swimming water birds are known to prefer wide water bodies to evade terrestrial predators by virtue of distance from shore (Weller *et al.*, 1995). Pong wetland and surrounding wildlife sanctuary support a rich avifauna comprising more than 220 species (Pandey, 1989). The wetland serves an excellent winter habitat for several thousands of migratory waterfowl, namely barheaded goose, pintail, common teal, spotbill, shoveller, mallard, gadwall, wigeon, brahminy duck, pochard, tufted duck and bluewinged teal.

Different institutions are working on the diversity of the wetlands of the Shiwaliks are given in Table-3.

Table No.3.

Sr.No.	Name of the Lake	Name of the Institution involved	Taxonomic Groups
1.	Mansar (J&K)	Jammu University; ZSI, Solan	Limnology, Fishes
2.	Suransar (J&K)	Jammu University	Limnology, Fishes
3.	Pong Dam (H.P.)	ZSI, Solan	All faunistic groups
4.	Ropar	ZSI, Dehradun; ZSI, Solan; Panjabi University; Punjab University. BSI, Dehra Dun.	All faunistic groups Flora
5.	Sukhna	Panjab University; ZSI, Solan	All faunistic groups
6.	Renuka	ZSI Solan, BSI, H.P.U.Shimla.	
7.	Asan	ZSI, Dehra Dun.	

3.2. Wild Biodiversity

3.2.1. Wild Animal Diversity

The Shiwalik region representing various states like Jammu & Kashmir, Punjab, Himachal Pradesh, Chandigarh, Haryana and Uttranchal, presents wide variety of fauna commensurating with diverse ecosystem like rivers, lakes, ponds, wetlands, forests. The area is with a network of seasonal and perennial streams where varied forms of life from Protozoa to mammals exist. The altitude varies from 300 to 1000 m above mean sea level. The Shiwaliks serve as buffer and barrier for infiltration of fauna and flora. These hills are known for high degree of endemism and even some geologically ancient animals like scaly anteater and burrowing frogs are present even today.

3.2.1.1. Species Composition

The Shiwalik Eco-region falls under three distinct biotic provinces (Rodger and Panwar, 1988); (i) Northwest Himalaya, west of Sutlej river; (ii) West Himalaya, east of Sutlej river; (iii) Semi-arid hot dry foothills. Habitat conditions offered by various kinds of forests, grasslands, soils, rivers and streams, lakes, under stones, rocks etc. are utilised by diverse faunal groups, ranging from microscopic Protozoa to large mammals.

So far about 3,119 species of animals are estimated to exist in the Shiwalik Eco-region (Table.....). These constitute about 3.5% of Indian fauna. Lower animals like invertebrates including insects are represented by 2,513 species, which form about 80.6 % of total wild animal diversity in the area. Higher animals (vertebrates) comprise of 606 species, constituting 19.6% of the Shiwalik fauna. Insects and other arthropods form a predominant group (2,233 spp.) among invertebrates, whereas birds comprising about 400 species dominate vertebrates. These estimates are based on available data, but the real numbers will rise further as and when more species are discovered.

Invertebrates

These organisms, in particular insects, are a significant component of faunal diversity that cannot be ignored in the assessment of biodiversity. They play an important role in maintaining various life processes, and form vital components in the food web of an ecosystem. The greatest pool of genetic diversity lies among these animals. Much interest has been shown on their ecology, physiology and diversity. But in terms of conservation policy they are most neglected. They are, however, indirectly conserved by way of habitat protection in the wildlife sanctuaries and national parks created for the conservation of higher animals like mammals, birds and reptiles.

Insect Diversity

About 2,102 sknown species of insects are estimated to exist in the Shiwalik Eco-region. Butterflies and moths (Order Lepidoptera) with about 600 species form the dominant

group. They are followed by Coleoptera (about 400 species), Hymenoptera (312 species), Hemiptera (300 species) and Diptera (about 130 species). High percentages of amphibiotic insects like dragon- and damselflies (Odonata) (18.4%) and mayflies (Ephemeroptera) (9.4%) in the Shiwalik ranges is primarily due to the fact that the area offers numerous and a variety of perennial as well as seasonal aquatic biotopes as habitats for their immature stages. However, another amphibiotic group, Trichoptera is represented by only 0.7% of Indian trichopterans as these insects are yet to be fully explored in this area.

Majority of insects is beneficial. They are important pollinators of crops, medicinal and other plants and agents of biological control of insect pest species. The role of predatory insects in controlling the population of various pests cannot be ignored. Insects also sustain several species of insectivorous avifauna. They also provide valuable products, e.g. honey and wax from *Apis* spp. (Hymenoptera), and non-mulberry silk from *Antheraea* spp. (Lepidoptera).

As elsewhere, most insects in the Shiwalik Eco-region are forest dwellers, and these cannot survive major habitat modifications. Environmental destruction and degradation have a devastating effect on insect populations. There is a great concern for the conservation of insects.

Noninsect Diversity

Non-insect invertebrates constitute 11.1% (280 species) of Shiwalik invertebrate fauna. Based on number of species, Nematoda with 132 species is the largest group followed by Arachnida (spiders, mites, scorpions) with 80 species, Platyhelminthes 45 species, Crustacea 40 species, Mollusca 35 species, Annelida 29 species, Protozoa 20 species, Myriopoda 11 species and Rotifera 10 species.

The most outstanding feature of non-insect invertebrate diversity in the Shiwalik Eco-region is the existence of several species of microscopic zooplanktons in freshwaters. These primarily belong to Crustacea and Rotifera, and form about 60% of food of various

commercially important and cultivable fishes; thus largely contributing to the maintenance of fisheries in the area. Common planktonic crustacean genera in this region are *Daphnia*, *Alona*, *Alonella* and *Chydorus* among Cladocera, and *Eucyclops*, *Mesocyclops* and *Neodiaptomus* among Copepoda. The rotifer plankton comprises species of *Asplanchna*, *Brachionus*, *Lecane* and *Keratella*.

Soil animals like earthworms (Oligochaeta) and millipedes (Diplopoda) are important components of non-insect invertebrate diversity. These organisms play a vital role in enhancing soil fertility in arable, pasture and forestlands due to their burrowing and feeding habits. Earthworm species of *Perionyx*, *Metaphire* and *Amyntas* found in the area are of great vermi-composting interest.

Some non-insect invertebrates are endoparasites, causing serious diseases in human beings and livestock; e.g. protozoans like *Plasmodium vivax* (Malaria), *Entamoeba histolytica* (Amoebiasis) and *Eimeria* sp. (Coccidiosis). Ectoparasitic leeches are of great nuisance as they attack man and his animals to suck their blood. Since ages, haematophagus habit of leeches has been exploited to cure throat and other inflammatory swellings. *Poecillobdella granulosa* has been used as a common medicinal leech in the Shiwalik region.

Nematodes, popularly called roundworms or threadworms, are one of the most economically important groups of non-insect invertebrates. They are found in all kinds of habitats. Nematodes have free living as well as parasitic mode of life. *Heterodera avenae* and *Anguina tritici* have been reported as destructive pests of wheat, whereas *Meloidogyne* spp. inflicts damage to all kinds of agricultural crops in the Shiwaliks and elsewhere.

Vertebrates

Mammalian Diversity

The mammalian fauna of the Shiwalik Eco-region is represented by 65 species, which constitute about 16.7% of the total Indian mammals (390 species). The mammalian fauna of the Shiwaliks shows strong Oriental affinities. Some big mammals occurring in the area are sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), jackal

(*Canis alpinus*), chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*) and common fox (*Vulpes bengalensis*). Some temperate mammals like Himalayan black bear (*Selenarctos thibetanus*) and goral (*Hemitragus jemlahicus*) are also found in the Shiwaliks. The range of leopard, *Panthera pardus*, extends from the subtropical Shiwalik region to the Temperate Zone.

Bird Diversity

The Shiwalik Eco-region harbours a very rich and diverse avifauna. About 400 species have been reported from the area, comprising 32.5% of the Indian bird diversity. Maximum number of resident birds occurs in the forested areas of these hills. Some of these are jungle fowl, large Indian parakeet, tree pie, wood shrike and yellow-throated babbler. Shallow waters of Maharana Pratap Sagar, Gobind Sagar, Ropar wetland and Asan reservoir with swampy riverside forest belt has not only provided habitat for resident water birds but an adequate wintering ground for many migratory water birds. Various species of gulls commonly found in the coastal areas are also noticed in fairly good numbers at Maharana Pratap Sagar.

The mixed moist deciduous and chir pine zone in the Shiwaliks attracts a number of birds endemic to temperate Himalayan region for wintering from December to March. Some of these are Griffon vulture, red billed blue magpie, laughing and whistling thrushes, Scimitar babbler, kaleej and chir pheasants, creepers, river chats, etc. Several species of birds from the Indian plains and peninsula also take refuge in these hills during the scorching summer heat.

Ecologically, the Himachal avifauna is very interesting. About 35.5% of birds are residents in this state and other parts of the country; 15.7% are winter visitors from S.E. Asia, Europe and Siberia; 11.6% are summer visitors from central India and foothills; 10.4% are altitudinal migrants; 26.8% are birds of Himalayan ecosystem and show vertical movements (Mahabal, in press). About 47% (210 species) of birds in Himachal Pradesh are insectivorous, and are important agents of biocontrol of insect pests of agriculture, horticulture and forests.

Pheasants, also known as game birds, are represented by 4 species in the Shiwaliks. These are kaleej pheasant (*Lophura leucomelana*), chir pheasant (*Catreus wallichii*), Indian peafowl (*Pavo cristatus*) and Indian junglefowl (*Gallus gallus murghi*). They are

spectacularly colourful birds and have brilliant metallic plumage. Due to extreme hunting pressure and loss of habitat their existence is seriously threatened. As a result kaleej pheasant and Indian peafowl are highly endangered and included under Schedule I of the Indian Wildlife (Protection) Act, 1972.

Reptilian Diversity

Altogether 48 species of lizards, snakes and turtles have been reported from the Shiwalik Eco-region. These constitute about 10.5% of Indian reptiles. Of four kinds of monitor lizards inhabiting India, two species, common Indian monitor (*Varanus bengalensis*) and yellow monitor (*Varanus flavescens*), occur in the area. Both species are on the endangered list. Main threats to the monitor lizards have been from the increasing trade in their skins.

The snake fauna in the Shiwalik hills consists of both poisonous and harmless species. Important poisonous snakes in the area are Russel's viper (*Vipera russelli*), common krait (*Bungarus caeruleus*), Indian cobra (*Naja naja*) and king cobra (*Ophiophagus hannah*). Some non-poisonous species are rat snake (*Ptyas mucosus*), checkered keelback water snake (*Xenochrophis piscator*) and rock python (*Python molurus*). Generally, people of the area do not kill snakes because of religious sanctity attached to them - thereby helping in the conservation of these creatures. A decline in snake population is primarily due to increase in urbanisation and loss of suitable habitat. The current status of rock python (*Python molurus*) is highly endangered. It is protected under Schedule I of the Wildlife Act. Exports of snakes and their product from India are also banned. Conservation of snakes is essential as they are effective rat killers and play a significant role in the upkeep of a healthy environment.

A few species of freshwater and mud turtles inhabit lakes and rivers in the Shiwaliks. Some of these are *Trionyx gangeticus* (Indian shell turtle), *Lissemys punctata* (Indian flap-shelled turtle) and *Kachuga kachuga*. The population of *Lissemys punctata* has declined considerably. It is an endangered species and has been listed in Schedule I of the Wildlife Act.

Amphibian Diversity

As many as 16 species of frogs and toads have been reported from the Shiwaliks. The predominant amphibian diversity in the area comprises species of *Rana*, *Amolops*, *Bufo* and *Microhyla*. Frog legs are considered a delicacy in many countries of the world. Till recently they were being exported in large quantities from India to China, Japan, France, USA, etc. One of the species involved in the export is the Indian bullfrog (*Rana tigerina*), occurring in several parts of the country is also found in this area. . Over-exploitation of this species has resulted in drastic decline in its population, and consequently the Government of India has now banned the export of frog legs. All species of *Rana* are included in Schedule IV of Indian Wildlife (Protection) Act, 1972.

Fish Diversity

Like other parts of the Himalayan ecosystem, some fishes of the Shiwalik hills are distinctive in possessing special features for survival in torrential streams and rivers. A total of 77 species have been recorded from the area. A number of these are endemic to the Shiwaliks and mainly belong to *Tor*, *Glyptothorax* and *Noemacheilus*. Mahseer (*Tor tor*, *Tor putitora*), mrigal (*Cirrhinus mrigala*), rohu (*Labeo rohita*), katla (*Catla catla*), calbasu (*Labeo calbasu*) and seenghala (*Mystus seenghala*) comprise major fisheries in the Shiwalik eco-region. The details of the wild animals species occurring in the Shiwalik region are given in Table - 4.

3.2.1.2. Endangered and Threatened Species

A number of animal species in the Shiwalik hills are endangered because of severe alteration and destruction of their habitats (Table - 5). Some species of water birds are also threatened due to deterioration of wetlands (Table - 6).

3.2.1.3. Endemic Species

Not much information is available on the endemicity of Shiwalik fauna. However the following species of fishes are considered as natives of the area:

3.2.1.3. Exotic Species

Very little is known on the exotic elements in the faunal diversity of the Shiwalik Eco-region. A few species of earthworms like *Ocnerodrilus occidentalis*, *Aporrectodea parvus* and *Dichogaster bolau* exotic in the area. Exotic species of earthworms are known to be carried in soil around roots of exotic plants. These species also have a parthenogenetic mode of reproduction, which helps them to colonise new areas. Exotic species of fishes are represented by *Cyprinus carpio* Linnaeus, *Catla catla* (Ham-Buch), *Hypophthalmichthys molitrix* Valenciennes, *Salmo trutta fario* Linnaeus and *Salmo gairdnerii* (Richardson).

3.2.2. Wild Plant Diversity

3.2.2.1. Species Composition

Non Vascular Plants Diversity

Besides being rich in vascular plants (flowering plants and ferns) the Shiwalik region is also inhabited by a variety of non-vascular plants, viz. algae, fungi, lichens, liverworts and mosses.

Algae

Algae are important as a source of food of the fishes, aquatic amphibia sps., mammals and other animals, viz., *Anabaena*, *Nostoc*, *Lyngbya*, *Oscillatoria* (blue green algae). *Cladophora*, *Hidrodictyon*, *Spirogyra*, *Oedogonium*, *Zygnema* etc.(Green algae). *Chara* and *Nitella* (stone wort), *Dichatomasiphon* and *Vaucheria* sps., (Yellow green

algae) and the red algae like *Batrachospermum sp.*, are found in fresh or salt water or ponds just after the rains.

Fungi

The fungi are a large group and are distinguished from other plants by the absence of chlorophyll. Fungi includes hundreds of species which are of tremendous economic importance to man. They play an important role in medicine yielding antibiotics, in agriculture by maintaining fertility of soil, forming basis of many industries and as important means of food. Some of them are highly poisonous to man and animals. Few common species of fleshy or woody like *Amanita*, *Agaricus*, *Aurificaria*, *Calavatia*, *Lycoperdon*, *Entoloma*, *Geastrum*, *Oxyporus etc.*, are common on dead woods or on damp soils.

Lichens

The plant body of the lichens consists of two different organisms viz., Fungi and Algae. The fungal component forms the greater bulk of the lichen thallus. It envelops the algal component. The reproductive organs, however, are fungal in character. Some of the species of lichens are of direct economic value to man, as valuable source of dyes and medicinal and perfumeries etc. The Shiwaliks region is not very rich in Lichens, however few common species are seen on rocks or tree bark, like *Arthonia*, *Graphina*, *Graphis*, *Permeliasp.*, etc.

Liverworts and Mosses

The Liverworts and Mosses (Bryophytes) in general are relatively of little economic importance. Some mosses provide food for herbivorous mammals, birds and other animals. Ecologically mosses are of considerable importance as these help in soil production and soil conservation. The humus is found in the course of time after death

and decay of mosses and liverworts. The Bryophytes usually form dense, extensive mats on the soil, preventing soil erosion. Some of the common liverworts are *Cyathodium*, *Marchantia*, *Plagiochesma*, *Riccia*, *Targionia* species and *Anthececos* (Hornworts) also seen in wet rocky places. The common mosses are *Erythrodontium* (on tree trunks), *Fissidens* (on shady moist ground), *Hymenostyliella* (on shady stone), *Hydrogonium* (on wet boulder), *Thudium* (on tree trunks) and *Plagiothecium* sp., is common in forests undergrowth of the Shiwaliks. The detail of the floral diversity is given in Tables 7-9.

Table – 7 Analysis of Vascular Plant Diversity

Classification	Families	Genera	Species
Pteridophytes:			
Fern Allies	2	2	3
Ferns	17	20	26
Angiosperms:			
Dicotyledons	103	454	721
Monocotyledons	21	136	252
Gymnosperms	2	3	3
Total	145	615	1005

Table – 8 Plant Diversity:-

Sr. No.	Taxon	No. of spp. in Shiwalik	No. of spp. in India	% in India
A.	Non Vascular Plant Diversity			
1.	Algae	Not much known	6,500	--
2.	Fungi	Not much known	14,500	--
3.	Lichens	Not much known	2,000	--
4.	Liverworts & Mosses	Not much known	2,850	--
B.	Vascular Plant Diversity			
1.	Pteridophyta	29	1,100	2.63
2.	Angiosperms	973	17,500	5.56
3.	Gymnosperms	3	64	4.6

Table – 9 TEN DOMINANT FAMILIES:

	Families	Genera	Species
1.	Poaceae	63	119
2.	Papilionaceae	41	95
3.	Asteraceae	41	57
4.	Cyperaceae	10	40
5.	Orchidaceae	19	31
6.	Euphorbiaceae	18	27
7.	Lamiaceae	18	25
8.	Malvaceae	10	23
9.	Acanthaceae	16	21
10.	Scrophulariaceae	12	18

Medicinal Plants

In India 2500 species of plants are largely used by pharmaceutical industries where 90% are collected from wild and 20 species are under commercial cultivation. India's traditional medicinal system are part of a time honored and time tested culture that has successfully used nature to treat primary and complex ailments over 3000 years. Every species growing on earth even the so called obnoxious weeds are subjected to biological screening to find out its activity which has brought in to focus various new sources of alkaloids, anti-malarial, anti-protozoan, anti-arthritic, anti-asthmatic, anti-ulcer, anti-diabetic, anti neuplastic and anti-inflammatory agents. Plants afford the care for drugs for cardiovascular diseases.

In Shiwalik Hills there are variety of medicinal plants growing in different areas and habitats. Some of them like Amla, Neem, Acacia (Kiker), Jamun, Banana, Tulsi etc. are occurring in wild and domesticated forms. Due to the side effects of Allopathic drugs these herbal drugs are more safe and these herbal drugs have an international market of more than 60 trillion pounds and expected o touch more than 10 times in the coming 50 years. In the world market Indian share for this trade is 1000 crores. Due to following reasons these are preferred.

- ◆ More safe.
- ◆ Comparatively cheap.
- ◆ Only source of health care for many.
- ◆ Eco friendly.

It is estimated that pharmaceutical industries of the developed nations already owes 1,12000 crore every year to the developing nations on plant based drugs used by them. In India there are more than 15000-20000 spp. of plants which, have medicinal value and at present only 7000-80000 are being used (Choudhary, 1996). In India nearly 400 species of plants are used by Pharmaceutical Industries and among these 90% are collected from wild and only 20 species are commercially cultivated. There are several institutions like CDRI Lucknow, CRI Kasauli (H.P.) and RRL Jammu who are playing an important role in creating database of medicinal plants. RRL Jammu has produced literature on the wealth of medicinal plants of the state. They have associated NGOs and

22 experts from institutes and industries by organising workshops on medicinal plants in October 2000. The activities of RRL Jammu are to prepare Directories, indigenous knowledge, bank market linkages and R&D activities. The data base information compresses of ethnological information, folk lores, house hold remedies, Pharmaeology, Formulations, general usage, adverse reactions dose conservation status. They also look commercial aspects, publications and patents. They are maintaining a herbarium on medicinal and aromatic plants, their common name, usage and distribution of species. The mandate of biodiversity is to conserve biodiversity, sustainable use and promoting indigenous knowledge and equitable benefit sharing. Some common medicinal and aromatic plants are given in Table –10. The plants which are used as insecticides and pesticides are given in Table – 11.

3.2.2.4. Exotic Plants

The invasion of exotic weeds such as lantana and congress grass has degraded the quality of natural habitats of the area. Exotic fast-growing trees (*Eucalyptus* sp.) have in several localities. Water hyacinth (*Ichornia* sp.) has encroached upon a number of standing waters.

3.3. Agricultural Ecosystem

2. Cultivated and Domesticated Biodiversity:

About 66 species of crops and 320 wild relatives.

- I) Cropping Pattern:** In all the states falling under Shiwalik hills majority of the areas are with undulating land where only less than 30% of the area is dependent upon main crops of wheat and very little area was canal irrigated. The dominant Rabi crops were with low consumption of water and dependent upon rains, like, Grams, Mustard, Sugar cane. Much of the land was dependent upon rains during the rainy season like Cotton, Jawar, Bajra, Pulses, Paddy. The areas where water table has come up there is a shift to paddy. The trends in market has a impact on the cropping pattern and the famous are switching over to wheat and paddy. The insecticides and pesticides are being excessively used to enhance the production.

Nearly 30% of the total available land for agriculture farmers are towards monoculture

II) Cash Crops: In commensurate with the public demand system nearly 10 % of the total area under cash crops of various types of seasonal vegetables like Cabbage, Cauliflower, Carrot, Radish etc.

III) Orchards: Much of the area of all the States is under orchards of Mango, Citrus and Litchi. Different delicacies of wild varieties of fruits are grown. Due to lack of proper markets and processing units farmers do not feel much encouraged.

3.4. Domesticated Biodiversity

No comprehensive information is available on the domesticated biodiversity of the Shiwalik Eco-region. However, the people grow the following traditional varieties of crops, pulses and fruits, and livestock.

3.4.1. Varieties of Crops, Pulses and fruits

Crops: Millets, Sunhemp, sugarcane and cotton.

Grain legumes & pulses: Field peas, French beans, black gram, horse gram, etc.

Oil seeds: Mustard, linseed and rai.

Spices & condiments: Turmeric and ginger.

Fruits: Mango, guava, citrus (lemon, orange, kinnow), litchi, phalsa, jamun, pomengranate, lasoora, mulberry, ficus, etc.

Vegetables: Potato, onion, pea, capsicum, French bean, tomato, radish, chillies, brinjal, cauli flower, cabbage, etc.

3.4.2. Animal Species and Varieties

- a) **Dairy Farming:** Usually Gaddis and Gujjars have been engaged in dairy farming leading a nomads life with seasonal migration from low to high altitudes and vice-versa but this as a part of green revolution has become the source of employment in almost whole Shiwalik hills. Several farmers are engaged in this profession. Various high milk producing races of Buffaloes and Jersey Cows are domesticated. The fodder of quality is also grown for getting better yield of milk. Even the nomadic communities like Gujjars, Gaddis and Bakarwal are moving towards permanent settlement in these hills.
- b) **Poultry and its Products:** The poultry and its products are marketed by some farmers and youth for earning their lively hoods. There are number of persons engaged in the domestication of good quality of poultry products. Various concerned Govts. have financed the projects and rendered advisory services for better producing varieties.
- c) **Goat, Sheep and Piggery:** Goats and Sheep are domesticated mainly by Gaddis, Bakarwals etc. who migrate in these hills during winter. Not much of improvement in live stock. Piggery as a source of lively hood is adopted by only very small section of the society.
- d) **Fish and fisheries:** Fish and fisheries are an important source of food for various neighboring sates and delicacies of the riverine fish like Labeo, Tor, Catla, Barilius, Mystus are well known. Various reservoirs like, Gobind Sagar, Thein Dam, Asan Dam, Pong dam and rivers in the foot hills and Shiwalik are overexploited by way of introduction of exotic fishes. Mahaseer, Labeo, Mystus and Cyprinus are important fishes of the area.
- e) **Apiculture:** Apiculture is also very common in these Shiwalik hills. Due to wide variety of Orchards, Oil seed crops, the apiculture has not been very commonly popularized.

3.5. Biodiversity Conservation

3.5.1. *In Situ* Conservation

The protected areas of the Shiwalik region are given in Table – 14.

C

3.5.2. *Ex Situ* Conservation

Serious *ex situ* conservation measures are limited to Renuka zoo.

CHAPTER- 4

STATEMENT OF PROBLEMS RELATED TO BIODIVERSITY

4.1. Wild Biodiversity

4.1.1.1. Habitat Destruction and Conversion of Land into Agriculture

4.1.1.1.1. Forests

Due to continuous and unscientific degradation of forests primarily to meet the requirement of timber with increased urbanization and development activities natural forests of Shiwalik have been replaced by several fast growing species . The shrinkage of forests environment has resulted in the loss of several animal species like biological pest controlling agents, pollinators, reptiles, birds, and other wild animals. The following important factors and issues are related to the loss of forests.

- Expansion of agriculture and horticulture.
- Demand for wooden packages.
- Excessive use of forests for fuel food and furniture.
- Submergence of forests for construction of dams for hydroelectric generation.
- Extensive grazing activities in the forests ecosystem.
- Encroachment of forests lands.
- Diversion of forestland for non-forests purposes.
- Decline of native plants like mango, jamun, bamboo, sacharum, *Caparis*, etc., which have traditionally played an important role in the economy of the local people.
- Decline in medicinal plants like amla, lasura, amla, harrar, neem, etc. that are commonly used as medicines for the cure of various ailments.

4.1.1.1.2. Grasslands & Pastures

Due to increased grazing, gullies are formed and the land becomes loose; thus an environment supporting various types of invertebrates and plants becomes ecologically degraded. Consequently, fertile fields of local farmers are facing the problems of silt deposition because of increased soil erosion. Selective feeding by the grazing livestock has resulted proliferation of undesired weeds, causing general degradation and destruction of habitat, and loss of wild biodiversity.

4.1.1.1.3 Arable Fields

Some of the factors responsible for the decrease of biodiversity in the arable fields are as follows:

- Intensification of vegetable and fruit crops with the excessive use of insecticides and pesticides.
- Removal of bushes and woods, which provide shelter of nesting and roosting to several species of birds and mammals including invertebrates.

4.1.1.1.4. Wetlands

In Shiwalik hills there are more than 2000 defined or undefined wetlands harboring nearly 350 species of birds, which are directly or indirectly dependent on them. Some of these are kingfishers, herons, egrets, paddy birds, wagtails, and bee-eaters, and migratory birds like wigeons, teals, cranes, ducks, pochards, spot bills, gadwall, mallards, pintail, etc. These wetlands are under threats due to following factors:

- Excessive silting due to increased activities like deforestation, construction of roads.
- Encroachment for agriculture.
- Proliferation of undesired aquatic weeds.
- Seepage of pesticides from nearby fields.
- Pollution from non-biodegradable material.

4.1.1.1.5. Rivers and Streams

The area of Shiwaliks is interspersed with more than 5000 streams and some rivers. Associated flora and fauna of these rivers and streams is under threat due to follows reasons:

- Unscientific removal of stones and sand for constriction.
- Pollution from sewerage and industrial wastes.
- Construction of dams and reservoirs.
- Dumping of debris and other wastes.
- Decline and loss of riparian vegetation.
- Decline in native fishery resources (Mahaseer and other migratory fishes) due to impoundment of river waters for hydroelectric projects. This has affected livelihood of poor fishermen and animal protein in the nutrition of people.
- Decline and changes in the faunal components in downstreams from the dam sites due to reduced waterflow.

Valuable agricultural land has been lost and several families have been displaced due to submergence of villages as a result of construction of river valley dams in the Shiwaliks. The displaced families have been settled in far-flung areas, even in other states. This has led to social conflicts within and between the families.

There has been general decline in fishery resources in almost all streams that has adversely affected the economy of local fishermen.

4.1.1.2. Introduction of Exotic Species

The area is losing its natural biodiversity due to the introduction of exotic species i.e. replacement of fast growing species, like poplar, *Eucalyptus* and *Acacia* at the cost indigenous species like *Sisso*, jamun, lasura, *Acacia* sp. (local species), babool etc. Hill stream and local fishers are unable to compete with exotic carp fishes like *Cyprinus carpo*, the later being predatory upon some local fishes.

4.1.1.3. Hunting

The forests of Shiwaliks have been providing a shelter to a rich population of diverse wild animals like deer, wild pigs, neelgai, leopards, etc and other forms of wild animal biodiversity. They had been under pressure of hunting since ages because of their proximity and easy accessibility to the people of the Indo-Gangetic Plains. Pinjore in Haryana Shiwaliks was once a popular hunting resort for the erstwhile rulers of the area. For table delicacies, these animals have been hunted and over exploited causing serious threats to their survival. As a result, the population of wild animals has drastically been reduced.

4.1.1.4. Over-exploitation of Herbal and Aromatic Plants

The indigenous plants like herbs and aromatic plants are harvested unscientifically and injudiciously by exploiting unemployed persons at very low daily wages by some private pharmaceutical firms. The local people and villages are unknown about the wealth of these herbs.

4.1.2. Domesticated Biodiversity

4.1.2.1. Shift to Monoculture

Due to market driven forces and pressures from the Departments of Agriculture and Horticulture, the people of the Shiwalik Hills are introducing high yields varieties of crops and monoculture, and are using extensively chemical fertilizers and pesticides. As a result low yielding indigenous and traditional varieties of crops like jawar, bajra, sesame and pulses are being neglected and lost rapidly.

4.1.2.2. Domestication of Hybrid Varieties of Livestock

Various local breeds of animals are also facing threat of extinction because of stress on domestication of high yield varieties of buffaloes, cows and poultry. This has also led to decline in the population of animal varieties that are used by small and marginal farmers for plough and transport.

4.2. Root Causes of Loss of Wild Animal Biodiversity

4.2.1. Alienation of People

Forests are major storehouses of faunal and floral diversity. Since ages, the local people have been utilizing bio-resources derived from wild habitats like forests in a sustainable manner, and they were concerned for their protection and conservation. The management of these forests is now under the control of the Forest Departments of different states falling under the Shiwalik Eco-region. As a result, various policies and plans for the conservation, management and development of forests are formulated and implemented by the officials of the department. The local people simply feel left out, and they are least interested in the conservation of forests and its biodiversity. They are further alienated by some restrictions on them for the collection of forest produce. There is an obvious feeling among the majority of people that management and propagation of biodiversity in the area is the responsibility of the government and its agencies, and they have no role to play in its conservation. Effective conservation of biodiversity is possible only through the active participation of the local people.

4.2.2. Non involvement of local communities

Generally majority of the people are not aware of various ecological benefits of conserving biodiversity particularly from lower animals like insects and other invertebrates. They also lack an understanding and awareness of the values of conservation of the whole range of faunal diversity of some sites such as wastelands, arable fields, pastures and grasslands. They perceive wild animal biodiversity as of large animals like mammals, birds, reptiles, etc. and show little interest in the maintenance and protection of invertebrates and other small animals.

4.2.3. Indifferent Attitudes of Developmental Departments/Agencies

Different departments and other agencies of the states in the Shiwaliks are carrying out various development works in the area. Some of their activities are detrimental to the maintenance and propagation of biodiversity. The construction work carried out by the Public Works Department, Housing Board and other agencies involves excavation of a huge quantity of debris, which is simply dumped or rolled down the roadsides with out any concern for the damage it may cause to the habitats of several species of invertebrates and other animals by way of loss of vegetation, erosion and clogging of stream channels. Similarly, the mining agencies involved in open cast mines roll the excavated debris down the hillsides or dump in streams.

The Departments of Agriculture and Horticulture recommend periodic application of inorganic fertilizers and toxic pesticides to enhance productivity in arable fields and orchards. They are least concerned about the damage these chemicals may cause towards the loss of non-target beneficial invertebrate biodiversity such as insect pollinators of crops and fruits, predatory and parasitic insects, earthworms, spiders, soil micro-arthropods, etc.

The main thrust of the Department of Wildlife is on the protection and conservation of big animals like large mammals and pheasants, although other animal life is also incidentally conserved in the protected areas like wildlife sanctuaries, national parks and reserves forests. There is very little concern for the propagation and protection of invertebrates outside the protected areas. Invertebrates form the major and vital components of animal diversity and are considered as the backbone of biodiversity of an ecosystem. Likewise major programme of the Fisheries Department is towards the culture of some species of fishes (carps) that are of commercial importance without caring for the conservation of no-commercial fishes and other aquatic fauna.

CHAPTER-5

MAJOR ACTORS AND THEIR ROLE IN BIODIVERSITY CONSERVATION

Various section of the society like agriculturists, farm laborers, industrialists, fishermen and other stakeholders are the actual owner of bioresources, but all other agencies like Central and State government research organization are instruments and advisors to safeguard the interests of common man. The role of all the above said agencies is to conserve and manage bioresources for sustainable development. The major actors and their roles are as follows:

5.1. NGOs

In Shiwalik hills there are more than 60 NGOs societies involved in the biodiversity conservation education, awareness and organization of training programmes with the support of various government departments. Some of them play key role in bringing various sections of the society and government departments for meeting the goals of sustainable development. Some agencies are also involved in encouraging cultivation medicinal plants.

5.2. State Government

5.2.1. Department of Forest and Wildlife

The departments of forest of various states are the managers of forest and its resources. With a team of officials in the district, they keep a watch on the illicit felling and poaching activities in the forest of respective jurisdiction. Various Kandi Projects are World Bank aided on the development of the watershed. Various afforestation programmes are being undertakes with the participation of local panchayats and farmers under Joint Forestry Management. Eco-restoration and eco-development programmes

help in controlling the degradation of soil of the Shiwalik hills. The interaction between institutes like University of Horticulture and Forestry, Department of Social Forestry, India Council of Forest Research Institute, Forest Research Institute, Forest Survey of India, State Forest Research Institute play a key role in development of forests.

5.2.2. State Council for Science, Technology and Environment

These institutions are the nodal agencies for carrying out various activities on behalf of the government. They organize various projects with the grants of Ministry of Environment and Forest, Ministry of Human Resources and Development, Department of Science and Technology and Department of Industries. They organize training workshops through interaction of various agencies for dissemination of data.

5.2.3. Department of Agriculture

Department of Agriculture of various states is playing a key role in field of agriculture development i.e. introduction of new high yields varieties. They have experimental plots and are involved farmer's contact programmes.

5.2.4. Department of Animal Husbandry

Various concerned states have their Department of Animal Husbandry to provide advisory services for domestication of different breeds of cattle, buffalo and poultry birds, and maintenance of goat, sheep and pig livestock.

5.2.5. Department of Fisheries

This department of various states is concerned with the implementation of various laws and legislation on managing fisheries resources. They help the people to harness fish resources.

5.2.6. Department of Horticulture

The whole belt of Shiwalik hills has horticulture crops of mangoes, citrus and litchi. Department of horticulture of various states is helping the farmers by advisory services for the production of better quality fruits.

5.2.7. Department of Irrigation

Department of Irrigation of various states is helping the farmers for increasing the land under cultivation by irrigation through the construction of earthen dams and management through village panchayats and watershed management societies.

5.2.8. Department of Industries

The department of industries of various states is involved in setting up of industries and canning units in and outside Shiwalik zone for utilizing horticulture produce so that farmers would get good support price for their produce.

5.2.9. Department of Education

It is involved in imparting formal education including biodiversity studies to students at school and college levels in all states under the Shiwalik Eco-region.

5.2.10. Department of Law

It is responsible for Formulating and enforcement of all biodiversity related laws and regulation.

5.2.11. Department of Mining

The Department of Mining of all states in the area are concerned only for increasing the mining area.

5.2.12. State Pollution Boards

They are responsible for monitoring all types of pollution in the Shiwaliks Eco-region.

5.3. Central Government**5.3.1. Department of Botanical Survey and Zoological Survey of India**

These are central government organization under MOEF, New Delhi, concerned with the inventorying floral and faunal resources of the country, with their regional stations at Dehra Dun and Solan. They also act as advisory bodies for assessing the status of various animal and animal plants, and their conservation and management techniques.

5.3.2. Regional Research Laboratory, Jammu

This institute is basically a research institute concerned with identifying the herbs and aromatic plants, which, can be used in production of herbal medicines. It is engaged in creating a database of various useful plants and their utilities.

5.3.3. National Bureau of Plants and Animal Genetic Resources

These institutions are concerned with the maintenance of germs plasm of various crops, forests and animal breeds. The centers are located at Shimla (NBPGR) and Karnal (NBAGR). They have the inventory of various genetic resources.

5.3.4. Wildlife Institute of India

This institute is located at Dehra Dun with its activities through out the country. The institute is concerned with the inventorying the wildlife resources, study of the habitat and an advisory body to the Government of India regarding the status of various wild animals in the country and suitable measures for its protection and management.

5.4. Universities

5.4.1. Universities of Agriculture, Horticulture and Forestry

There are four universities in the region viz. Punjab Agriculture University, Ludhiana; Himachal Pradesh Krishi Vishwa Vidhyala; Palampur, Unioversity of Horticulture and Forestry, Solan; Agriculture University, Hissar; G.B. Pant Agricultural University, Pantnagar. These institutions play a crucial role in maintaining and propagation of various bioresources.

5.4.2. University Concerned with Studies on Basic Science

Various scientists in basic sciences of Botany and Zoology of Jammu University; Guru Nanak Dev University; Punjabi University, Punjab University; H.P. University; Kurukshetra University, and Kumaon University are involved in the various aspects of the studies on biodiversity. The taxonomic work on fish, butterflies & moths, Coleoptera, herpetology, birds and mammals are being undertaken in universities like Punjab (fish and some groups of insects), Punjabi (insects), Jammu (fish, reptiles), Kurukshetra (pests of medicinal plants, algae and birds, and PAU, Ludhiana (mammals).

CHAPTER-6

GAPS

6.1. Wild Biodiversity (Plants & Animals)

6.1.1. Gaps in Information

- (i) Different institutions in six states and one union territory are engaged in the conservation of the biodiversity and other resources in the Shiwalik co-region without any interstate coordination and cooperation. Biodiversity conservation programmes, thus, do yield desired results.
- (ii) Several agencies/organizations are involved in wild biodiversity studies and research. Knowledge available with them is scattered in various scientific journals & books. There is no coordination for sharing information among themselves.
- (iii) Biodiversity studies on lower plants (algae, fungi, mosses and lichens) and invertebrate animals are very meager.
- (iv) Information on the intra-species genetic diversity of wild biota is negligible.
- (v) Studies are lacking on the interrelationships between exotic and native species of plants and animals.
- (vi) Not much work has been done on interrelationships between insect pollinators and crops, medicinal plants and other wild flora.
- (vii) Hardly any information exists on the effect of poisonous pesticides on non-target pollinators of crops and wild flora.
- (viii) Very little information is available on the populations of wild animal species.
- (ix) Status of most of the endangered species is yet to be assessed.
- (x) Environmental impacts of developmental projects like dams, mines, industry, etc. on biodiversity have been assessed in most of the cases.

- (xi) Interrelationship between different ecosystems and wild biodiversity (plants, animals) are not properly understood.

6.1.2. Gaps in Vision

- (i) Different state governments are carrying out present conservation programmes on wild biodiversity with little participation of other stakeholders.
- (ii) Biodiversity concerns are often ignored while implanting developmental projects like construction of dams, canals and roads.
- (iii) There is a thrust on the plantation of exotic trees under social forestry programmes.
- (iv) Existing preservation plots for the conservation of genome of healthy plants of *Shorea robusta* (Sal) are neglected.
- (v) Funds for biodiversity conservation programmes are very meager as compared to developmental projects.
- (vi) Shortage of funds for Joint Forest Management (JFM) programmes that envisage involvement of village committees in the protection, development, management and regeneration of degraded forest habitats.
- (vii) Insufficient funds for taxonomic studies.
- (viii) There are hardly extensive programmes to check soil erosion on hill slopes.
- (ix) Over exploitation of biodiversity products.
- (x) Lack of fish ladders in dams for the migration of native migratory fishes like mahaseer for spawning in their breeding grounds in upstream.
- (xi) Inadequate discharge of water in down streams from the impounded waters for the survival of aquatic fauna.

6.1.3. Gaps in Policy and Legal Structure

- (i) The entire Shiwalik eco-region has been designated as backward area. The government provides incentives for the promotion of the industries in the

region. This has caused destruction to natural eco-system and wild species of animals and plants.

- (ii) All stakeholders are not involved in formulating policies relating to biodiversity conservation.
- (iii) Biodiversity related policies and legislation are not enforced vigorously and effectively.
- (iv) Policies are lacking for the conservation of wild biodiversity outside protected areas.
- (v) There are no guidelines / policies to tackle the situation due to the human-wild life conflicts, especially on the compensation given to the aggrieved parties because of loss of crops by wild animals.
- (vi) Prosecution of poachers of wild animals and violation of forests acts take a very long time in civil courts.
- (vii) Lack of policy for long-term financial compensation to farmers and others whose productive lands have been submerged in reservoirs as a result of construction of river valley dams.
- (viii) Settlements of displaced persons due to river valley projects in far away places in other states.
- (ix) Meager financial support for biodiversity issues while formulating / sanctioning development projects.
- (x) Politicians / administrators often ignore biodiversity issues while formulating / sanctioning development projects.
- (xi) There are no policies and legal measures to check excessive exploitation of wild medicinal plants.

6.1.4. Gaps in Institutions and Human Capacity

- (i) Shortage of trained personnel (taxonomists) for preparing biodiversity inventories, especially for lower animals and plants.
- (ii) Taxonomic / biodiversity studies are neglected in almost all institutions in the area.

- (iii) Biodiversity studies are hampered due to lack of simple and pictorial field guides on the fauna and flora of the region.
- (iv) Shortage of trained personnel for environmental Impact Assessment and Evaluation.
- (v) There is no mechanism for the involvement of pharmaceutical agencies and other in sharing financial investments in the regeneration of rare and over exploited medicinal plants.
- (vi) No *in situ* & *ex situ* measures exist for the conservation and propagation of threatened animals like rock python, Indian pangolin, amphibians (*Rana* spp.), monitor lizards (*Varanus* spp.) etc.
- (vii) Wild animal and plant resources are yet to be documented at district level for better monitoring.
- (viii) Lack of *in situ* conservation measures for best declining populations of Golden Mahaseer and other native hill stream fishes.

6.2. Domesticated biodiversity

6.2.1. Gaps in Information

- Information in tradition farming is being eroded increasingly.
- There is no consolidated information on the various types of domesticated animals breeds and seeds of traditional varieties.
- Nutrition value of traditional varieties of crops has been investigated in detail.
- Data is not available on the resistance of traditional crops to pests and the same holds good for the breeds of domesticated animals against parasites.
- Information is lacking on the drought resistance varieties of crops.

6.2.2. Institutional Gaps

- Little effort is being made for the conservation of genome of traditional varieties of crops and livestock.
- Trained personnel are lacking for recognizing various types of traditional crops.

- Infrastructure is lacking for storing genome of various varieties of traditional crops and breeds of livestock.

6.2.3. Gaps in Vision

- The farmers are shifting towards farming based on modern high yield varieties of crops.
- The people are now undertaking domestication of high yield breeds in poultry and diary farming, ignoring the traditional breeds.
- Shift in the cultivation favoring non-leguminous plants.
- There are very few employment opportunities in the Shiwalik Eci-region.

6.2.4. Gaps in Policies and Legal Structure

- Agriculture policy emphasizes cultivation of cash crops that hardly contribute to natural soil fertility.
- Extensive use of pesticides and inorganic fertilizers for higher yields.

There are no legal measures for the conservation of rare domesticated

CHAPTER – 7

STRATEGIES AND ACTION PLAN

7.1 Wild Biodiversity

7.1.1. People Participation

- ◆ Encourage active involvement of all stakeholders in biodiversity conservation programmes.
- ◆ Involve all stakeholders in formulating policies related to conservation of wild biodiversity.
- ◆ Local Panchayats to maintain a biodiversity register listing plants and animals used by local people as medicine, food, dyes, pesticides, etc.

Actors: Department of Forest, State Councils of Science & Technology of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.1.2. Human Conflict and Wild Biodiversity

- ◆ Formulate clear policies and guidelines to mitigate hardships of local communities in terms of loss of crops and livestock because of increase in the population of some wild animals.
- ◆ Introduce crop insurance or financial compensation of crops loss due to wild animals.

Actors: Department of Forest and Wild Life of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.1.3. Protection and Conservation of Wild Habitat and Species

- ◆ Provision for annual monetary aid (like payment of royalty) to displaced families from the revenue of hydroelectric project for compensating

submergence of their agricultural land and houses, and loss of their livelihood, which was dependent on biodiversity of the area.

- ◆ settlement of displaced families near the site of submergence of their villages.
- ◆ Provision of jobs for displaced families in the developmental project.

7.1.4. Protection and Conservation of Wild Habitat and Species

7.1.4.1. Restoration of Degraded Wild Habitats

- ◆ Restoration of degraded habitats by afforestation programmes involving plantation of native species of trees.
- ◆ To control soil erosion by plantation of grasses (preferably fodder species) on hill slopes.

Actors: Department of Forests and Soil Conservation, State of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Union Territory of Chandigarh.

7.1.4.2. In Situ Conservation

- ◆ Encourage conservation strategies keeping in view peoples needs and dependence on bioresources.
- ◆ Establish a wild life protected area for Dhar forest range (district Gurdaspur, Punjab) on view of threats to wild life from the construction of nearby Ranjit Sagar dam on River Ravi.
- ◆ Encourage *in situ* conservation of Golden Mahaseer and other native hill stream fishes.
- ◆ Assess traditional knowledge of local communities for in-situ conservation of wild diversity.
- ◆ Prepare specific working plans for the maintenance of existing preservation plots for the sal (*Shorea robusta*) trees. Establish preservation plots for other important timber trees like *Acacia* spp., *Dalbergia sissu*, etc.

Actor: Department of Forests, Wild Life, Fisheries, State Council of Science and Technology of State of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh, and MOEF.

7.1.4.3. Ex Situ Conservation

- ◆ *Establish biological Parks for the conservation of threatened animal species like rock python, monitor lizards, Indian pangolin and amphibians, and for the conservation of rare medicinal and aromatic plants.*

Actor: Department of Forest and Wild Life of State of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh, MOEF CSIR, Pharmaceutical Industries and BSI.

7.1.4.4. Organisational Coordination

- ◆ Establish an effective mechanism to coordinate and promote conservation of wild biodiversity and other resources among all states and union territory in the Shiwalik eco-region.
- ◆ Establish a single point information centre on wild life biodiversity database for all key actors in Shiwalik eco-region.

Actor: State Science and Technology Department of State of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.1.4.5. Creation of database

- ◆ Prepare a consolidated wild biodiversity database available with various research organizations/universities in the Shiwalik Ecoregion.
- ◆ Prepare village biodiversities registers, and district level simple and pictorial field guides of the fauna and flora for better monitoring.

Actors: BSI, ZSI, RRL (Jammu), NBPGR, Academic and Agricultural Universities of different states of India, ICAR, NBAGR, Fish Genetic Resources, Wild Life Institute, Dehra Dun, State science and technology department and forest department of states of Jammu & Kashmir, Punjab, Himachal, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.1.4.6. Studies, Research and Training

- ◆ Encourage ongoing studies in taxonomy, population and ecosystem association of all groups of animals and plants with special emphasis on lower animals and lower plants.
- ◆ Create ample job prospects for taxonomists.
- ◆ Initiate researches on intra-specific genetic make up of wild biodiversity (animals & plants).
- ◆ Undertake studies on status and population of threatened wild animals.
- ◆ Undertake studies on the status and distribution of rare plants.
- ◆ Encourage investigations on interrelationships between exotic and native species, between pollinators and plants (especially medicinal plants and crops), and between ecosystem and wild biodiversity.
- ◆ Intensify environmental impact studies of toxic pesticides and other pollutants, and developmental projects on wild biodiversity.
- ◆ Undertake faunistic and floral surveys of unexplored areas.
- ◆ Ensure training of all persons involved in biodiversity programmes in new concept of biodiversity.

Initiate studies on the diseases of wild animal biodiversity

- ◆ Undertake studies on the productivity of wetlands.
- ◆ Determine key stone species of plants and animals in different eco-systems.

- ◆ Sensetise politicians and administrators on biodiversity concerns and issues.

Actors: BSI, ZSI, RRL (Jammu), NBPGR, Academic and Agricultural Universities of different states of India, ICAR, NBAGR, Fish Genetic Resources, Wild Life Institute, Dehra Dun, State science and technology department and forest department of states of Jammu & Kashmir, Punjab, Himachal, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.1.4.7. Policy and Legislation

- ◆ Effective enforcement of all biodiversity act and laws.
- ◆ Provide legal protection to habitats of the key, priority of threatened species of animals and plants.
- ◆ Formulate policies for conservation of wild biodiversity outside protected areas.
- ◆ Establish separate authority for speedy disposal of cases related to poaching and violation of Forest Acts.
- ◆ Formulate policies of legal measure against over exploitation of medicinal plants, aromatic plants and other bioresources.
- ◆ Provide fish ladders during construction of all hydroelectric dams for migration of fishes (especially mahaseer fish) to their breeding grounds.
- ◆ Raise stock of native migratory fishes (mahaseer fish) by artificial breeding for release in affected streams.
- ◆ Increase waterflow of at least 40% of impounded waters for propagation of aquatic fauna as was in practice in pre-independence days.

Actors: Department of Forest and Law of state of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh, MOEF •

7.1.4.8. Financial Measures

- ◆ Liberal financial investments in all biodiversity conservation programmes.
- ◆ Provide liberal funds for Joint Forest Management (JFM) programmes.

- ◆ Provide special fund for taxonomic studies
- ◆ Involvement of pharmaceutical industry in financial investments for conservation of rare medicinal and aromatic plants.
- ◆ Liberal compensation for damage to crops and loss of life due to attack of wild animals.

Actors: Department of Finance of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.2. Domesticated Biodiversity

7.2.1. People Participation

- ◆ Involvement of farmers in all matters concerning agricultural policies and practices.
- ◆ Involvement of people in policies related to poultry and animal husbandry.
- ◆ Encourage domestication of naive breeds of livestock.
- ◆ Encourage cultivation of traditional varieties of crops.
- ◆ Encourage fish culture of native species of fishes.
- ◆ Intensify self-reliant eco-friendly income generating programmes such as sericulture, apiculture, mushroom culture, poultry, fish culture, vermiculture, etc.
- ◆ Discourage use of highly toxic pesticides.

Actors: Departments of Agriculture, Horticulture, Fisheries and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.2.2. Creation of Database

- ◆ Creation of database on various varieties of traditional crops and domesticated animals.
- ◆ Creation of database of pharmaceutical and biotechnology institutions involved in utilizing local varieties of plants and animals.
- ◆ Compilation of information on traditional knowledge and methods of farming in the region.

Actors: Department of Agriculture, Horticulture and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Union Territory of Chandigarh; Agriculture Universities of the region; Botanical Survey of India; NBPGR, ICAR, CSIR.

7.2.3. Studies, Research, Training & Capacity Building

- ◆ Encourage studies on the genome of traditional crops and native domesticated animal biodiversity.
- ◆ Encourage studies of nutritional value of traditional crops.
- ◆ Encourage studies on resistance of traditional crops to pests and native domesticated animals to parasites.
- ◆ Identify drought resistance varieties of traditional crops.
- ◆ Undertake training of personnel for recognizing traditional crops.

Actors: Department of Agriculture and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Union Territory of Chandigarh; NBPGR, ICAR, CSIR, Agricultural Universities of the region.

7.2.4 Ex Situ Conservation

- ◆ Storage and conservation of genome of traditional crops and native varieties of livestock in institutions/genome banks.

Actors: Department of Agriculture and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Union Territory of Chandigarh; NBPGR, ICAR, CSIR, Agricultural Universities of the region.

7.2.5. Policy and Legislation

- ◆ Agricultural policy to encourage cultivation of leguminous plants and non-cash crops.
- ◆ Formulate an act for conservation of rare domestic biodiversity.

Actors: Departments of Law, Agriculture, Horticulture and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.2.6. Financial Measures

- ◆ Provision of higher support price for cultivation of traditional varieties of crops.
- ◆ Encourage insurance of traditional varieties of crops.
- ◆ Create markets for traditional varieties of crops.
- ◆ Public Distribution System (PDS) to undertake marketing of traditional varieties of crops at subsidized rates.

Actors: Departments of Finance, Agriculture, Horticulture, Animal Husbandry and Civil Supplies of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.3. Education, Awareness & Training

7.3.1. Education

- ◆ Develop specific courses on biodiversity in the curricula for all levels of college, school and university education.
- ◆ Encourage nature study, field trips for students to national parks, wild life sanctuaries, sacred groves, etc.
- ◆ Encourage participation of students in easy biodiversity related activities/projects like listing of common birds, insects, plants etc. around educational institutions.
- ◆ Produce a document listing simple biodiversity related activities/projects for educational institutions.
- ◆ Produce a simple and pictorial field guides for the identification of common plants and animals of Shiwalik region in English, Hindi and regional languages.
- ◆ Organise quiz programmes, declamation contests and essay writing on different aspects of nature for all age groups of students.
- ◆ Encourage participation of local communities and other stakeholders in educational programmes on biodiversity related conservation issues.

- ◆ Produce simple short-term courses on biodiversity conservation in Hindi and regional languages for local communities and others.

Actors: Council of Science & Technology, Department of Education, of State of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh, MOEF, CSIR, NGOs, UGC Pharmaceutical Industries and BSI.

7.3.2. Awareness

- ◆ Encourage maximum participation of all stakeholders in biodiversity awareness camps.
- ◆ Produce simple publicity material (posters, brochures, etc.) on various aspects of biodiversity.
- ◆ Prepare illustrated booklets of easy identification of common and threatened animals and plants for generating interest on biodiversity.
- ◆ Optimum use of TV, Radio and print media for creating awareness on biodiversity.
- ◆ Establish an interstate coordination agency for participation of people in water conservation.
- ◆ Create awareness about harmful effects of long term use of chemical fertilizers and pesticides among farmers.
- ◆ At present, different agencies in different states are carrying out education and awareness on biodiversity in the Shiwaliks with little impact on the people.

For better coordination and interaction between various concerned organizations, a common center is required on priority for dissemination of information through training, and production and distribution of publicity material on the biodiversity of the Shiwaliks. Details of proposal are given in Appendix IV.

Actors: Council of Science & Technology, Departments of Education & Publicity of State of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar

Pradesh and Union Territory of Chandigarh, MOEF, CSIR, NGOs and all Biodiversity related institutions in the

Actors: Department of Agriculture and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh; NBPGR, ICAR, CSIR, Agricultural Universities of the region.

7.2.5. Policy and Legislation

- ◆ Agricultural policy to encourage cultivation of leguminous plants and non-cash crops.
- ◆ Formulate an act for conservation of rare domestic biodiversity.

Actors: Departments of Law, Agriculture, Horticulture and Animal Husbandry of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.2.6. Financial Measures

- ◆ Provision of higher support price for cultivation of traditional varieties of crops.
- ◆ Encourage insurance of traditional varieties of crops.
- ◆ Create markets for traditional varieties of crops.
- ◆ Public Distribution System (PDS) to undertake marketing of traditional varieties at subsidized rates.

Actors: Departments of Finance, Agriculture, Horticulture, Animal Husbandry and Civil Supplies of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

7.3. Education, Awareness & Training

7.3.1. Education

- ◆ Develop specific courses on biodiversity in the curricula for all levels of college and university education.

- ◆ Encourage nature study, field trips for students to national parks, wild life sanctuaries, sacred groves, etc.
- ◆ Encourage participation of students in easy biodiversity related activities/projects like listing of common birds, insects, plants etc. around educational institutions.
- ◆ Produce a document listing simple biodiversity related activities/projects for educational institutions.
- ◆ Produce a simple and pictorial field guides for the identification of common plants and animals of Shiwalik region in English, Hindi and regional languages.
- ◆ Organise quiz programmes, declamation contests and essay writing on different aspects of nature for all age groups of students.
- ◆ Encourage participation of local communities and other stakeholders in educational programmes on biodiversity related conservation issues.
- ◆ Produce simple short-term courses on biodiversity conservation in Hindi and regional languages for local communities and others.

Actors: Council of Science & Technology, Department of Education, of States and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh, Union Territory of Chandigarh, MOEF, CSIR, NGOs, UGC, Department of Science and Technology, BSI.

7.3.2. Awareness

- ◆ Encourage maximum participation of all stakeholders in biodiversity awareness programmes.
- ◆ Produce simple publicity material (posters, brochures, etc.) on various aspects of biodiversity.
- ◆ Prepare illustrated booklets of easy identification of common and threatened animals and plants for generating interest on biodiversity.
- ◆ Optimum use of TV, Radio and print media for creating awareness on biodiversity.

- ◆ Establish an interstate coordination agency for participation of people in water conservation.
- ◆ Create awareness about harmful effects of longterm use of chemical fertilizers & pesticides among farmers.
- ◆ At present, different agencies in different states are carrying out education and on biodiversity in the Shiwaliks with little impact on the people.

For better coordination and interaction between various concerned organization a common center is required on priority for dissemination of information through and production and distribution of publicity material on the biodiversity of the Shiwaliks. Details of proposal are given in Appendix IV.

Actors: Council of Science & Technology, Departments of Education & Public Health of State of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Union Territory of Chandigarh, MOEF, CSIR, NGOs and all related institutions in the area.

- ◆ Prepare specific working plans for the maintenance of existing preservation plots (Shorea robusta) trees. Establish preservation plots for other important timber trees like Acacia spp., Dalbergia sisso, etc.

Actor: Department of Forests, Wild Life, Fisheries, State Council of Science and Technology of State of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh, and MOE

7.1.4.3. Ex Situ Conservation

- ◆ Establish biological Parks for the conservation of threatened animal species like python, monitor lizards, Indian pangolin and amphibians, and for the conservation of medicinal and aromatic plants.

Actor: Department of Forest and Wild Life of State of Jammu and Kashmir, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh, MOEF CSIR, Pharmaceutical Industries and BSI.

7.1.4.4. Organisational Coordination

- ◆ Establish an effective mechanism to coordinate and promote conservation of wild biodiversity and other resources among all states and union territory in the Shiwalik region.
- ◆ Establish a single point information centre on wild life biodiversity database for all actors in Shiwalik eco-region.

Actor: State Science and Technology Department of State of Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttaranchal, Uttar Pradesh and Union Territory of Chandigarh.

Appendix-I

Medicinal & Aromatic Plants of Shiwalik Hills

Sr.No.	Name	Vern Name
1.	<i>Abrus precatorius</i>	Ratti, Gunja
2.	<i>Aegle marmelos</i>	Bilve, Bilpatri
3.	<i>Asparagus racemosus</i>	Shatavar
4.	<i>Bryonopsis laciniosa</i>	Shivlingi
5.	<i>Cassia fistula</i>	Amaltas
6.	<i>C. absus</i>	Chaksu
7.	<i>C. tora</i>	Chakramarda
8.	<i>C. occidentalis</i>	Kasmarda, Kasondi
9.	<i>Celastrus paniculatus</i>	Malkangni, Jyotishmati
10.	<i>Centella asiatica</i>	Mandookparni, Brahmi
11.	<i>Centratherum anthelminticum</i>	Somraji, Ghorajiri
12.	<i>Cinnamomum camphora</i>	Camphor tree, Kapur
13.	<i>C. tamala</i>	Tejpatra
14.	<i>Citrullus colocynthis</i>	Indrayan
15.	<i>Clerodendrum indicum</i>	Bharangi
16.	<i>Cordia dichotoma</i>	Lasura
17.	<i>Costus speciosus</i>	Kemuk keu
18.	<i>Crataeva nurvala</i>	Varuna, Barna
19.	<i>Croton tiglium</i>	Jamalgota,
20.	<i>Curculigo orchiioides</i>	Kalimushli
21.	<i>Cymbopogon</i> spp.	Lemon grass, Citronella grass, Palma rosa grass
22.	<i>Desmodium gangeticum</i>	Sahalparni
23.	<i>Didymocarpus pedicellate</i>	Patharpori, Shilapushpa
24.	<i>Dolichos uniflorus</i>	Kulath
25.	<i>Eclipta prostrata</i>	Bhringraj, Bhangra

26.	<i>Embelica ribes</i>	Baibidang
27.	<i>Foeniculum vulgare</i>	Mithi saunf
28.	<i>Gloriosa superba</i>	Kalihari, Langli
29.	<i>Glycyrrhiza glabra</i>	Mulhatti
30.	<i>Gmelina arborea</i>	Gambhari
31.	<i>Helicteres isora</i>	Marorphali
32.	<i>Holarrhena antidysenterica</i>	Kutaja, Indrajau
33.	<i>Ipomoea hederacea</i>	Kaladana
34.	<i>Lepidium sativum</i>	Chandrashur
35.	<i>Madhuca butyracea</i>	Phalwara, Chiura
36.	<i>Madhuca indica</i>	Mahuha, Mahwa
37.	<i>Matricaria chamomilla</i>	Babuna
38.	<i>Melia azadirachta</i>	Bakain, Mahanim
39.	<i>Melissa officinalis</i>	Bililotan, Balm
40.	<i>Moringa oleifera</i>	Sohanjan
41.	<i>Mucuna pruriens</i>	Kaunch
42.	<i>Murraya koenigii</i>	Mithinim
43.	<i>Nerium indicum</i>	Lal Kaner
44.	<i>Ocimum sanctum</i>	Tulsi
45.	<i>Olea europaea</i>	Olive
46.	<i>Operculina turpethum</i>	Nishoth, turpeth
47.	<i>Oroxylum indicum</i>	Arlu
48.	<i>Plumbago zeylanica</i>	Chitrak, Chita
49.	<i>Pongamia pinnata</i>	Karanj
50.	<i>Pueraria tuberosa</i>	Bidarikanda, Siali
51.	<i>Punica granatum</i>	Darim, Anar
52.	<i>Putranjiva roxburghii</i>	Jiyapota
53.	<i>Randia dumetorum</i>	Rada, Madanphal
54.	<i>Rauwolfia serpentina</i>	Sarpagandha
55.	<i>Ricinus communis</i>	Castor, Erand
56.	<i>Salvia officinalis</i>	Salvia, Safahuss

57.	<i>Sapindus mukorossi</i>	Ritha, Soapnut
58.	<i>Scilla indica</i>	Bhuikanda
59.	<i>Semecarpus anacardium</i>	Bhillawa
60.	<i>Solanum indicum</i>	Brihati
61.	<i>Solanum viarum</i>	Banbhindi
62.	<i>Solanum surattense</i>	Kantkari
63.	<i>Sophora mollis</i>	Buna, Sakina
64.	<i>Spilanthes acmella</i>	Akarkara
65.	<i>Spondias pinnata</i>	Ambara
66.	<i>Strobilanthes auriculata</i>	Kapurminjar
67.	<i>Swertia chirayita</i>	Chirayata
68.	<i>Terminalia arjuna</i>	Arjun
69.	<i>T. bellirica</i>	Bahera
70.	<i>T. chebula</i>	Harad
71.	<i>T. tomentosa</i>	Asan
72.	<i>Thevetia peruviana</i>	Pila Kaner
73.	<i>Tinospora cordifolia</i>	Guduchi, Giloe
74.	<i>Trichosanthes cucumerina</i>	Patol
75.	<i>Tylophora indica</i>	Damabuti
76.	<i>Urginia indica</i>	Jangli piaz, squill
77.	<i>Valeriana jatamansi</i>	Nihani, Mushkbala
78.	<i>Vetiveria zizanioides</i>	Khaskhas
79.	<i>Vinca rosea</i>	Sadabahar
80.	<i>Viola odorata</i>	Banaksha
81.	<i>Vitex negundo</i>	Nirgundi
82.	<i>Viscum album</i>	Banda, Mistletoe
83.	<i>Vithania coagulens</i>	Ashwagandha
84.	<i>Woodfordia fruticosa</i>	Dhataki pushpa
85.	<i>Xanthoxylum armatum</i>	Tejbal
86.	<i>Zingiber officinale</i>	Zinger, Sunthi

Appendix-II

PLANTS FOR INSECTICIDE AND PESTICIDE INDUSTRY

Sr.No.	Botanical Name (Family)	Common/Vern Name	Parts used
1.	<i>Acorus calamus</i> Linn. (Araceae)	Bach, Bare Calamus root	Leaves & rhizomes, calamus oil
2.	<i>Adinda cordifolia</i> Roxb. (Rubiaceae)	Haldu	Bark & Juice
3.	<i>Agava americana</i> Linn. Iagavaaceae)	Kantala, Century Plant	Leaves & Roots
4.	<i>Semecarpus anacardium</i> (Anacardiaceae)	Bhillawa	Juice/Sap
5.	<i>Arachne cordifolia</i> syn. (Euphorbiaceae)	Gurguli	Leaves
6.	<i>Arisaema tortuosum</i> Wall (Araceae)	Samp-ki-khumb Snake maize	Tubers
7.	<i>Artemisia absinthium</i> Linn. & <i>A. Vulgaris</i> Linn.	Wormwood Villaiti afsantin	Flowering tops/ Essential oil
8.	<i>Azadriachta indica</i> <i>A. Juss</i> (Meliaceae)	Neem Margosa tree	Leaves, Bark & oils.
9.	<i>Berberis aristata</i> (Berberidaceae)	Kashmal Rasount, Daruhaldi.	Extract & Salts
10.	<i>Boenninghausenia albiflora</i> (Hook) (Rutaceae)	Pissumar buti	Leaf extract, essential oil
11.	<i>Butea monosperma</i> Lamk. (Leguminosae)	Dhak, Palash, Flame of the forest.	Seeds
12.	<i>Croton tiglium</i> Linn. (Euphorbiaceae)	Jayapal, Jamalgota, Purgincroton	Seeds

13.	<i>Curcuma longa</i> Roxb. (Gingibersaceae)	Haldi, Turmeric	Rhizomes
14.	<i>Cymbopogon nardus</i> Linn. (Graminae)	Katrin, Citronella, grass	Leaves oil
15.	<i>Delphinium verstitum</i> Wall <i>D. brunnoninum</i> Royle (Ranunmculaceae)	Juhi Salyan, Laskar	Roots, leaves
16.	<i>Diospyros montana</i> Roxb. (Ebenaceae)	Bistendu, Lohari Mountain-persimon	Fruits & crushed leaves
17.	<i>Eucalyptus globulus</i> Labill. (Myrtaceae)	Kapurmaram, Blue gum.	Leaf, decoction and oil
18.	<i>Euphorbia royleana</i> Boiss. (Euphorbiaceae)	Thuhar, Thor, Danda, Thor, Shakar Pitam	Latex (Milky)
19.	<i>E. thymifolia</i> Linn. (Euphorbiaceae)	Chhoti dudhi, Rakta Vinda, Chada	Plant, oil
20.	<i>Gloriosa superba</i> Linn. (Liliaceae)	Gigers claws, Glory lily, Kalihari Langli	Root (Rhizomes)
21.	<i>Hedychium acuminatum</i> Rosc. (Zingiberaceae)	Kapur kachri, Kachur Shati	Rhizome, essential oil
22.	<i>Holarrhena antidysenterica</i> (L.) (Apocyanaceae)	Kutaj, Kurchi, Indraju, Ivory tree	Bark & seeds
23.	<i>Kalanchoe spathulata</i> (Poir) (Crassulaceae)	Tatara, Haiza	Leaves
24.	<i>Madhuca latifolia</i> (Roxb.) (Sapotaceae)	Mahua	Mahua meal, a residual cake after extraction of oil from the seeds.
25.	<i>Nicandra physaloides</i> Gaertn. (Solanaceae)	Apple of Peru	Decoction of leaves
26.	<i>Nicotiana tabacum</i> Linn <i>N. rustica</i> Linn.	Tobacco Tambakhu	Alkaloid Nicotine/plant extract

27.	(Solanaceae) <i>Ocimum gratissimum</i> Linn. <i>O. sanctum</i> Linn. (Labiatae)	Ram-tulsi, Tulsi	Essential oil
28.	<i>Picrasma quassioides</i> (D. Don) (Simaroubaceae)	Charangi, Karwi, Bering Quassia	Stem wood
29.	<i>Pieris ovalifolia</i> D. Don (Ericaceae)	Anyar	Leaves
30.	<i>Polygonum hydropiper</i> Lin. (Polygonaceae)	Jal Marich Pachir Mool, Ghaniri	Leaves & Herbs
31.	<i>Ricinius communis</i> Linn. (Euphorbiaceae)	Erand, Castorbean	Seeds, leaves
32.	<i>Saussurea costus</i> Clarke (Compositae)	Kuth	Roots
33.	<i>Sophora mollis</i> R. Grah. (Leguminosae)	Buna, Sakina, Arghavan	Seeds
34.	<i>Trigonella foenum-graecum</i> Linn. (Papilionaceae)	Methi, Fenugreek	Plant, dried leaves
35.	<i>Vitex negundo</i> Linn. (Verbenaceae)	Bana, Sura Nirgundi	Leaves
36.	<i>Zanthoxylum armatum</i> DC. (Rutaceae)	Tirmir, Tejbal Tumburu	Fruits, branches and thorns.

Appendix-III

Rare Plants : The rare plants of the Shiwalik region are given below

PTERIDOPHYTES

FAMILY: HYPODIMATIACEAE

1. *Hypodimatium crenatum* (Forssk.)

B) ANGIOSPERMS

FAMILY: MALVACEAE

2. *Hibiscus caesius* Garcke
3. *Hibiscus vitifolium* L.

FAMILY: TILIACEAE

4. *Corchorus tridens* L.
5. *Grewia asiatica* L.
6. *Grewia disperma* Rottl.
7. *Grewia hirsuta* Vahl

FAMILY: MALPIGHIACEAE

8. *Aspidopterys wallichii* Hook.f.

FAMILY: BURSERACEAE

9. *Boswellia serrata* Roxb.

FAMILY: ANACARIDIACEAE

10. *Rhus parviflora* Roxb.

FAMILY: PAPILIONACEAE

11. *Argyrolobium album* Bhattacharya
12. *Argyrolobium roseum* (Camb.)
13. *Canavalia gladiata* (Jacq.)
14. *Crotalaria sessiliflora* L.
15. *Crotalaria hirsuta* Willd.
16. *Desmodium tortuosum* (Sw.)
17. *Indigofera hochstetteri* Baker
18. *Lablab purpureus* (L.)

19. *Trigonella incisa* Benth.

20. *Vigna radiata* (L.)

FAMILY: ROSACEAE

21. *Rosa brunonii* Lindl.

FAMILY: CUCURBITACEAE

22. *Momordica dioica* Roxb.

FAMILY: RUBIACEAE

23. *Kohautia gracilis* (Wall.)

FAMILY: ASTERACEAE

24. *Catamixis baccharoides* Thomson

25. *Glossocardia bosvallea* (L.f.)

26. *G. bidens* (Retz.)

FAMILY: CAMPANULACEAE

27. *Campanula benthamii* Wall.

FAMILY: PRIMULACEAE

28. *Androsace umbellata* (Lour.)

FAMILY: MYRSINACEAE

29. *Myrsine africana* L.

FAMILY: OLEACEAE

30. *Jasminum auriculatum* Vahl.

FAMILY: LOGANIACEAE

31. *Mitreola petiolata* (J.F.Gmelin)

FAMILY: SCROPHULARIACEAE

32. *Buchnera hispida* Buch.

33. *Striga asiatica* (L.)

FAMILY: LAMIACEAE

34. *Eremostachys superba* Royle

FAMILY: PIPERACEAE

35. *Piper nepalense* Miq.

FAMILY: ELAEAGNACEAE

36. *Elaeagnus parvifolia* Wall.

FAMILY: URTICACEAE

37. *Neodistemon indicum* (Wedd.)

FAMILY: ORCHIDACEAE

38. *Cymbidium macrorhizon* Lindl.

39. *Eulophia dabia* (D.Don)

40. *Spiranthes sinensis* (Pers.)

41. *Tropidia pedunculata* Bl.

FAMILY: LILIACEAE

42. *Allium clarkei* Hook

43. *A. jacquemontii* Kunth.

44. *Asparagus racemosus* Willd.

FAMILY: PONTEDERIACEAE

45. *Monochoria vaginalis* (Burm.f.)

FAMILY: COMMELINACEAE

46. *Amischophacelus axillaris* (L.)

FAMILY: ARECACEAE

47. *Wallichia densiflora* Mart.

FAMILY: CYPERACEAE

48. *Cyperus pilosus* Vahl.

49. *Fimbristylis nutans* (Retz.)

50. *Fuirena wallichiana* Kunth.

FAMILY: POACEAE

51. *Apocopis paleacea* (Trin.)

52. *Anthraxon nudus* (Steud.)

53. *Arundinella pumila* (Hochst.)

54. *Oropetium thomaeum* (L.f.)

55. *Panicum notatum* Retz.

Appendix-IV

Number of wild Animals in Shiwalik Hills.

Taxa	Species		% India
	Shiwalik Hills	India	
Protozoa	20	2,577	0.8
Porifera	3	486	0.6
Cnidaria	2	842	0.2
Platyhelminthes	45	1622	2.8
Rotifera	10	330	3.0
Nematoda	132	2850	4.6
Acanthocephala	2	229	0.9
Mollusca	35	5070	0.7
Annelida	29	840	3.5
Arthropoda			
Crustacea	40	2934	1.4
Myriapoda	11	262	4.2
Arachnida	80	5818	1.4
Insecta			
Apterygotes	10	277	3.6
Ephemeroptera	10	106	9.4
Odonata	92	499	18.4
Orthoptera	92	1750	5.2
Phasmoda	3	146	2.0
Dermaptera	22	320	6.9
Blattaria	8	186	4.3
Manoptera	20	162	12.3
Isoptera	34	253	13.4
Hemiptera	300	6500	4.6
Thysanoptera	50	693	7.2
Neuroptera	10	335	2.8
Coleoptera	400	15500	2.6
Siphonaptera	3	52	5.8
Diptera	130	6093	2.1
Lepidoptera	600	10000	6.0
Trichoptera	6	812	0.7
Hymenoptera	312	10000	3.1
Bryozoa	2	200	2.0
Pisces	77	2546	3.0
Amphibia	16	209	7.7
Reptilia	48	456	10.5
Aves	400	1232	32.5
Mammals	65	390	16.7

Appendix-V

Endangered and Threatened Species

A number of animal species in the Shiwalik hills are endangered because of severe alteration and destruction of their habitats (Table - 5). Some species of water birds are also threatened due to deterioration of wetlands (Table - 6).

Endangered Animals in Shiwalik Hills protected under Indian Wildlife (Protection) Act, 1972 (Schedule I) (Source: Anonymous, 1994)		
Common Name	Scientific Name	Status
Reptiles		
Indian Flap-shelled Turtle	<i>Lissemys punctata</i>	V
Common Indian Monitor	<i>Varanus bengalensis</i>	E
Yellow Monitor	<i>Varanus flavescens</i>	E
Indian Rock python	<i>Python molurus</i>	E
Birds		
Chir Pheasant	<i>Catreus wallichii</i>	
Indian Peafowl	<i>Pavo cristatus</i>	E
		V
Mammals		
Oriental Small Otter	<i>Anoxy cinerea</i>	V
Leopard	<i>Panthera pardus</i>	V
Indian Pangolin	<i>Manis crassicaudata</i>	V
E –Endangered; V – Vulnerable		

Appendix-VI

Threatened Water birds of Shiwalik Eco-Region.

(GT= Globally Threatened; EX= Extinct; CR= Critically Endangered; EN= Endangered; T= Threatened;
NT= Near Threatened; I= Indeterminate; R= Rare; VU= Vulnerable; UnKn= Unknown)

Sl. No.	Species	Collar et al. (1194)	Red Data Book IUCN (1990)	ZSI (1994)	Directory of Indian wetlands (1993)	IWL(P Schedu (1972)
A.	Waterbirds:					
01.	Spottedbilled or Grey Pelican <i>Pelecanus p. philippensis</i>	GT/VU	I	--	EN	--
02.	Darter or Snake-bird <i>Anhinga rufa melanogaster</i>	NT	--	--	UnKn	IV
03.	Painted Stork <i>Mycteria leucocephala</i>	NT	--	--	--	--
04.	Opnbill Stork <i>Anastomus oscitans</i>	NT	--	--	--	--
05.	Black Stork <i>Ciconia nigra</i>	--	--	--	--	--
06.	White ibis <i>Threskiornis aethiopica</i> <i>Melanocephala</i>	NT	--	--	--	--
07.	Indian Black Ibis <i>Pseudibis papillosa papillosa</i>	NT	--	--	--	--
08.	Spoonbill <i>Platalea leucorodia major</i>	--	--	EN	--	I
09.	Barheaded Goose <i>Anser indicus</i>	--	--	---	T	--
10.	Marbled Teal <i>Marmaronetta angustirostris</i>	GT/VU	VU	--	T	I
11.	White-eyed Pochard <i>Aythya nyroca</i>	GT/VU	--	--	T	--
12.	Nakta or Comb Duck <i>Sarkidiornis melanotos melanotos</i>	--	--	--	--	--

13.	Eastern Merganser <i>Mergus merganser orientalis</i>	--	--	--	T	contd.. --
14.	Eastern Common Crane <i>Grus grus lilfordi</i>	--	--	--	--	--
15.	Indian Sarus Crane <i>Grus antigone antigone</i>	NT	--	--	--	--
16.	Sociable Lapwing <i>Vanellus gregarius</i>	GT/VU	R	--	--	--
17.	Wood Snipe <i>Capella nemoricola</i>	GT/VU	1	--	--	--
18.	Blackbellied Tern <i>Sterna acuticauda</i>	GT	--	--	--	--

3.2.1.3. Endemic Species

Not much information is available on the endemism of Shivalik fauna. However the following species of fishes are considered as natives of the area:

1. *Tor chillinoides* (McClelland)
2. *Noemacheilus rupicola* (McClelland)
3. *N. montanus* (McClelland)
4. *N. horai* Menon
5. *N. kangrae* Menon
6. *Glyptothorax pectinopterus* (McClelland)
7. *G. conirostris* (Steindachner)
8. *G. stoliczkae* (Steindachner)

Appendix- VII

Protected Areas in Shiwalik Hills					
Sr.No.	Name of the Area	Status	Area	District	State
1.	Mansar				J & K
2.	Suransar				J & K
3.	Pong Dam			Kangra	H.P.
4.	Gobind Sagar			Bilaspur	H.P.
5.	Renuka			Sirmour	H.P.
6.	Naina Devi			Bilaspur	H.P.
7.	Simbal Bara			Sirmour	H.P.
8.	Takhni Rehmanpur			Hoshiarpur	Punjab
9.	Jhajjar Bacholi			Roop Nagar	Punjab
10.	Nepli			Chandigarh	Chandigarh
11.	Kanjli			Chandigarh	Chandigarh
12.	Kalesar Wildlife Sanctuary			Yamuna Nagar	Haryana
13.	Rajaji National Park			Saharanpur	U.P.
14.	Chalei				U.P.
15.	Motichur Sanctuary			Dehradun	Uttaranchal

Executive Summary

NBSAP Shiwalik – Ecoregion

1. The Shiwalik hills are the chain of mountains running to parallel the Himalayas with approximately 800 kms in length and 8-40 kms in width which are extending from Uttar Pradesh to Jammu & Kashmir stretching across the states of Uttaranchal Pradesh, Haryana, Himachal Pradesh, Union Territory of Chandigarh and the state of Punjab. There is a net work of drainages and major rivers like the Jhelum, the Tawi, the Beas, the Sutlej , the Yamuna, the Ganga, in additions to the tributaries of these rivers. This region is the life line and gate way for the enhanced biodiversity and prosperity of north-west for the states like Jammu & Kashmir, Punjab, Rajasthan, Haryana, Uttaranchal, Uttar Pradesh and Delhi in addition to union Territory of Chandigarh.
2. The era of Shiwalik system of rocks is called the age of Mammals which has lead the geo-scientists to probe into the mysteries of evolution. These hills are ecologically fragile and centre of endemism. There were once dense forests nearly two hundred years back with rich wildlife. More than 1000 species of plants including 350 economically important and 135 species of medicinal and aromatic plants are known. Nearly 2000 species of animals with approximately 30% of vertebrates and 70% of invertebrates are known. The various rivers passing through these hills have been

rendering services of carrying nutrients from the forests of the main Himalaya and Shiwalik hills and increasing the land fertility and neighbouring states.

3. The excessive and liberal use of chemical fertilizers and pesticides for accelerating the growth in the farms, orchards and cultivation fields has led towards toxic pollution in the streams causing a severe damage to aquatic flora and fauna. The consumption of chemically strained varieties of food are health hazards.
4. There are several man made concrete and earthen dams constructed on the above said rivers and other minor hill streams developed for the generation of electricity and irrigation purposes which are responsible for bringing out green revolutions, industrialization and providing employment particularly in the northern sector.
5. Various developmental activities like mining i.e. extraction of sand ,removal of boulders from river beds, extraction of timber, lack of coordination amongst various government, private sectors, research organizations and stake holders by way of inadequate Environmental awareness, education and training has led towards the loss of economically rich gene pool.
6. The displaced villagers and poor village folk from where the prosperity has reached to various adjoining states by way of construction of dams and generation of electricity remained under the shadow of poverty till today.
7. In view of the above lacunae and gaps, the strategies and actions were discussed through interactions of various state government agencies like Department of agriculture, Department of Forests, Department of horticulture, Universities and

Central government organizations, NGO,s and stake holders including women folk concerned with the developmental activities falling in the Shiwalik region.

8. There is an urgent need for setting up Environmental education, awareness and training centre to cater the needs of northern states for conserving and preserving natural gene pool.
9. The distribution of Power and irrigation must be managed through a committee comprising of representatives of the benefiting states including stakeholders.
10. A cess may be levied to the benefiting states and the amount should be made available for the development of the effected and displaced villages.
11. A strong data base for the biodiversity is required to be developed for the area and the biodiversity register may be made available at the village level and the royalty must be fixed for the harvesting of bio-resources.
12. For the utilization of water resources and generation of electricity, only 60% of the water should be allowed and 40% must be ensured for the down flow(as practiced by the Britishers) with the construction of ladders for the breeding and migration of fishes from down stream to upstream and vice-versa to ensure development of fisheries and fisherman's livelihoods.
13. The canning industries, pickle industries, weaving, poultry farming, milk dairy, pigeries, animals husbandry, fisheries, food processing units, cultivation of medicinal plants, handicrafts i.e. basket making and plantation of soil binding species of bamboo should be encouraged for the village folks especially women. The rules and regulations concerning the approval of pickle industries for the consumption of local

fruits must be liberalized. The approval of locally available fruit processing units should be available at least in the state.

14. To avoid the man and wildlife conservation conflicts, a proper and effective management of wildlife is required.
15. The coordination between various government and research organization and stakeholders is required to consider the research priorities.
16. Monoculture should be discouraged and cropping of new economically important species of medicinal and aromatic plants may be encouraged.
17. Establishment of biological Parks for conserving the gene pool.
18. Formulation of policies for checking the over-exploitation of medicinal plants.
19. Establishment of special courts for speedy disposal of hunting and poaching cases.
20. Provision of special funds for taxonomic studies.
21. Encouragement in the form of subsidies for the use of bio-fertilizers, sowing of traditional crops, domestication of old poultry races and old gene pool of bullocks.

CHAPTER – 8

REFERENCES

- Angiras, N.N. 2000. Biology and management of obnoxious weeds of Shiwaliks, 471-482. In: Mittal, S.p., Aggarwal, R.K. and Samra, J.S (eds). *Fifty years of research on sustainable resource management in Shivaliks*. Central Soil and Water Conservation Research and Training Institute Research Centre, Chandigarh.
- Anonymous. 1990. IUCN *red list of threatened animals*, 92 pp. IUCN, Gland, Switzerland.
- Anonymous. 1993. *Directory of Indian wetlands*, 264 pp. WWF-India, New delhi and AWB-Kaula Lumpur.
- Anonymous. 1994. *The Red Data Book of Indian Animals*. Part 1 : Vertebrata (*Mammalia, Aves, Reptilia and Amphibia*). Zoological Survey of India, Calcutta.
- Anonymous. 1995. Convention on international trade in endangered species of wild fauna and flora (CITES).
- Anonymous. 1997. The Wildlife (*Protection*) act, 1972 (*as amended up to 1993*), 158 pp. Natraj Publisher, Dehra Dun.
- Champion G.H and Seth S.K. 1968. A revised survey of the forest types of India, 404 pp. Manager of publication, Government of India, Delhi.
- Chaudhuri, R.S 2000. Geology of the Siwalik group of western and central Himalaya, 3-16. Soil resource of N-W Shiwaliks for persepctive land use planning: 23-24. In: Mittal, S.P., Aggarwal, R.K. and Samra, J.S. (eds). *Fifty years of research on sustainable resource management in Shivaliks*. Central Soil and Water Conservation Research and Training Institute Research Centre, Chandigarh.
- Collar, N.J., Corsby, M.J. and Stattersfield, A.J (1994). *Birds to watch. 2: The world list of threatened birds*, 407 pp. Birdlife International, Cambridge.
- Julka, J.M. 2000. Introduction. In: Fauna of Renuka Wetland. Zoological Survey of India, Calcutta: pp. 1-3.
- Katiyar, V.S. and Mittal, S.P. 2000. Problems of torrentsand their control in Shiwaliks, 267-274. In Mittal, S.P., Aggarwal, R.K. and Samra, J.S. (eds). *Fifty years of research on sustainable resource management in Shivaliks*. Central Soil and

