NATIONAL BIODIVERSITY STRATEGY & ACTION PLAN
WESTERN HIMALAYAN ECOREGION

WESTERN HIMALYAN ECOREGIONAL BIODIVERSITY STRATEGY AND ACTION PLAN

PREPARED UNDER THE NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN – INDIA

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Preamble

The National Biodiversity Strategy and Action Plan (NBSAP), a project of Union Ministry of Environment and Forest (MoEF) aims to produce a series of planning documents dealing with the conservation of India's biodiversity, sustainable use of its biological resources, and equity including in decisions regarding to the access to such resources and the benefits accruing from them. The project is funded by the Global Environment Facility (GEF) through United Nations Development Programme (UNDP). A unique aspect of the project is that its technical execution is by a Technical and Policy Core Group (TPCG) being coordinated by an NGO Kalpavriksh, and its administrative coordination is by Biotech Consortium India Ltd.

The NBSAP process has included extremely widespread consultation across the country and across all sectors of society, involving tens of thousands of people. It aims to produce not one national action plan, but 18 local (substate) plans, 33 state and union territory plans, 10 ecoregional (interstate) plans, and 13 thematic plans. All these will coalesce into a national plan, but will also remain independent for implementation purposes. In addition, over 30 thematic papers have been commissioned on a variety of topics related to biodiversity.

With this overall process, one of the ecoregional action plans is on Western Himalayan Ecoregion, which has been drafted by Prof. S.P. Singh, Coordinator along with persons experienced in the field.

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Preface

The present report consists of two main components, the first gives an overview of the existing biodiversity and the unique geoecological features of Western Himalaya, and the second part raises various issues related with the region, and suggests strategies and action plans.

During the course of this exercise it was realised that the ecosystem services provided by the Western Himalayan region are enormous and should be incorporated while preparing the BSAP. In fact, one of the reasons why we need biodiversity is that is contributes to ecosystem services. This process was facilitated by the positive stand taken in this regards by Dr. Ashish Kothari, Kalpvriksh and Coordinator TPCG NBSAP. It was a pleasure working with the members of the Ecoregional Group who spared time despite their busy schedule for this exercise and exchanged knowledge, views and ideas enthusiastically.

Western Himalayan ecoregion is fairly well documented unit because of its long history of forestry operations during the British period. Some of the first international forestry experts such as Troup and Champion worked in this region. However, issues of biodiversity management could never attain its due place and forestry remained focussed on simply the use of the forest. The progress in this area could not keep pace with the needs of conserving biodiversity and ecosystem services.

While developing this report attempts were made to consider viewpoints from all stakeholder groups, such as representatives of Van Panchayats, officials of state forest departments and NGOs. That many of us have been a part of this region and closely associated with many of the issues helped us in analysing various aspects of biodiversity.

The present BSAP may have many shortcomings, particularly because of time constrains as all members had to carryout their usual responsibilities while preparing the SAP. We would have liked to collect firsthand information and direct interactions especially with the people living in isolated areas. Our exercise on giving estimates of resources required for the implementation of the action plans was inadequate. In fact,

it required inputs from experts of concerned fields, which however, could not be available.

We are aware of the fact that we have raised quite a few issues which many would find striking hard at the status quo, but we honestly feel that there is a need to address them to have some hope of protecting biodiversity despite more than a billion people and an economic policy encouraging more consumptive traits. Such issues include: payment to people of biodiversity rich areas, valuing the intangible ecosystem services and allowing it to influence national accounting, drastic restructuring of forest services so as to address the issues of biodiversity and ecosystem services effectively, and relief to women from day-to-day drudgery for effective participation and to make organically produced food a socially sustainable activity.

Acknowledgements

The author wishes to express thanks to Dr. Ashish Kothari of Kalpavriksh for his critical comments on the BSAP and inputs during various stages of its development. Dr.Virendra Sharma (DFID), Dr. Vibha Ahuja (BCIL), Dr. Seema Bhatt (Kalpavriksh) and have also contributed to our BSAP by providing their annotations from time to time. The institutional support given by Dr. P.S. Roy, Indian Institute of Remote Sensing, Dehradun in holding the first workshop of Western Himalayan Ecoregion Working Group, preparing and analysing remote sensed data for this work is thankfully acknowledged. Gratitude is also expressed to the Ministry of Environment and Forests, Government of India, New Delhi for providing the opportunity and also the funding to this nationwide exercise of which we became a part.

Executive Summary

The Western Himalayan Ecoregion (WHE) encompasses a wider ecological breadth than the entire Indian sub-continent because of the combined effect of the ranges it covers in altitude, latitude and moisture regime. The Eastern Himalayan region compares well with the WHE in altitude, but has a narrower range in latitude and moisture. The climate of WHE extends deeper into colder and drier parts of the gradients than that of the eastern Himalaya. Then, WHE nurses a much greater region of the plains through the services of its ecosystems than any other region, largely because of its river connections. It represents an extraordinary combination of tropical and temperate forests with the unique characters evolved within the boundaries of youthful and ever-rising mountains. WHE is one of the centres of evergreen oaks with unique ecosystem properties, hence of global significance. An evergreenness that combines characters of deciduous species is shared also by pine, maple, a fact with which the world is unfamiliar. Our pine stands are partially naked during a few weeks of summer, while throughout the world pines are known for leaves with several years (up to 12 yrs) of lifespan. In the west, maple is a symbol of deciduousness, but our maples also include evergreen species.

The vast stretches of alpine meadows and snow that occur beyond the altitudes of forests represent an additional ecological dimension of the region. These are the areas where many species may migrate as global warming occurs.

The young and rising Himalayan ranges are highly vulnerable to landslide and erosion. Overexploitation of natural forests for commercial purpose in the past, and ongoing degradation of medicinal plants and poaching, chronic disturbance of forests for day-to-day living of the people suffering from poverty, invasion of exotic species and inappropriate planning processes have severely stressed both the diversity and ecosystem functioning in the Western Himalaya.

Important issues and related strategies and action plans concerning the ecoregion are as following:

Value ecosystem services and biodiversity of WHE and incorporate them into "national accounting"

Recognise the biodiversity and ecosystem services of WHE and incorporate them into the national accounting to enable the people to conserve natural forests and other ecosystems. India must have a certain area under protective (forest) system to sustain its productive systems (agriculture in the plains) and the ongoing economy based on the consumptive traits of over a billion people. This needs to be seen in view of the economic policy which seeks solving the problem of unemployment and economic growth by promoting consumptive traits. It is ironical that the more the consumptive trait we aim at achieving the more is the need of having a larger and healthy protective system with the capacity to dampen the effect of gaseous wastes and to control soil erosion and destabilising hydrological and other forces. Therefore, a certain amount of protective ecosystem should be kept away from the consumption-based economy. The three WHE states need to join hands not only to strengthen their claim for payment for providing ecosystem services, but also to restore the health of the ecosystems and the biodiversity therein.

Incorporating ecosystem services into national accounting may mean, as an example - providing cooking gas at an affordable price to the people living in the WHE or national support to generate enough hydroelectricity in the hills to meet the people's need of cooking food and of keeping rooms warm, at least until forests revive their self-regenerating capacity. WHE States have a high potential for electricity generation, and that could be realised with the support of the Central Government. The latter should invest in electricity generation in return of the ecosystem services the remaining areas of the country are getting from the forests of WHE.

Integrate ecology, economics and equity issues

The organic food production by hill farmers (free of toxic chemicals) can be treated as a kind of ecosystem service, but it is being maintained at the cost of natural forests and women's health. This ecologically sound way of food production can be justified only when necessary steps are taken to provide alternative sources of organic

matter (e.g. strengthening community and individual farm forestry) so that it does not lead to deforestation and drudgery-reducing tools for women (e.g. thrashers, dehuskers, etc.). Integrating ecology, economics and social equity is important to achieve sustainability. Several more steps may be required to make women's participation effective, and to enable them to express effectively.

It is notable that the "save seeds movement" ("beej bachao andolan") was born in the villages of WHE without any input from the scientific or administrative world. By cultivating diverse crop varieties these farmers are allowing evolution to continue. This should be treated as a major biodiversity and sustainability initiative by the hill farmers, and payment should be made to them for this kind of ecological service to the world.

Problems of fresh water lake degradation, particularly in Kashmir and Nainital, have connection to the lack of understanding of ecosystem services and connection between lake and its watershed. The lakes could be restored and managed by valuing services provided by the ecosystem processes.

Develop and expand participatory management in the region around the Van Panchayat model of Uttaranchal

Let the Uttaranchal's time-tested Van Panchayat (VP) be the sole institution for community forest management, and the basis for participatory management of forests and biodiversity also in other States after making necessary modification to suit the area-specific requirements of the people. **The VP model should not be unnecessarily disturbed by JFM or other such institutions imposed without the prior acceptance of the people.** JFM cannot be a substitute of VP, but it may damage it severely. If required, the positive points of JFM could be incorporated in the functioning of VPs. VPs doing well should be given incentives. The VPs could work in many villages almost without any outside financial support, while JFM is a project based exercise, with no arrangement for its sustenance after the expiry of the grant.

The need for an effective participation

Participatory approach is generally taken as an "add on" to an activity; therefore it fails to yield results. In a way, participatory approach amounts to a healthy and expanded form of democracy. It is far greater an exercise than is being held out. It warrants creating conditions conducive to the participation of the people. For example, the hill women need to be provided labour and time saving tools that give relief to them from the day-to-day drudgery and enable them to play their participatory role. It calls for sensitisation of the bureaucracy, scientists and others so that they can effectively collaborate with the people who are weaker and often work in a helpless condition. This also calls for seeking opinion of experts by "powerful" bureaucrats in an honest way, not merely for the sake of listing their names in support of decisions already taken. **Building an environment for participation is necessary in all walks of life.** Clear-cut tenure systems and certainty of rights are required to encourage people to participate in conservational activities.

Challenges of changing goals of forestry

The modern forestry has to be ecological with the goal of conserving biodiversity and ecosystem integrity. The "sustainable yield of goods" is no more the overriding factor. To deal with this situation, the forestry services need to be drastically modified to include experts who can address the issues of conserving biodiversity and ecosystem integrity in the world changing at an unprecedented rate. The forestry service at present consists only of pure administrators with training that is no more useful for managing forests as home to biodiversity and provider of precious ecosystem services, kept away from the market.

Give importance to natural regeneration of forest trees

The over-emphasis on plantations, protection of individual trees (e.g. ban on tree cutting over 1000 m altitude), and promotion of a few fast growing individuals (plus trees) have trivialised the importance of natural tree regeneration, that makes the basis for the perpetuation of forests, forest dynamics and evolution.

Make necessary changes in Forest Acts to safeguard the process of regeneration (seed crop, seed germination, seedling recruitment and establishment, and their becoming seedling and then trees). The three states of WHE could combine their resources to improve the understanding of regeneration processes as many important species are common.

Treat the management of PAs as a specialised and separate service

Keeping this in view a separate service at ecoregional or national level could be created. Recruitments should be made from those who have expertise in wildlife management, ecosystem aspects, socioeconomics with specialisation in participatory management, etc.

Review the blanket ban of tree cutting periodically and make the laws more area- and forest type-specific

The blanket ban on tree cutting has halted forest degradation but has caused new problems, as excessive lopping of broadleaved species and expansion of chir pine, has stifled progress in the development of forest-based local economy, and has reduced the unit of conservation from forest ecosystem to individual trees, which is irrational. Excessive lopping of tree branches (so much so that trees stop producing leaves) along with grazing and, litter collection and burning have created a regime of chronic disturbance (slow, invisible but persistent disturbance, never allowing a system to recover, and it crumbles as the effects of chronic disturbance accumulate in time), which degrades forests, particularly by damaging regeneration.

A chir-pine forest system, which thrives on disturbance including tree cutting, could, therefore, be used for developing enterprises at community level or by a suitable village level organisation. Similarly, alder which is an early successional species with a short rotation cycle (8-10 yrs) can be used to generate economy. This disturbance-dependent tree species is a great nitrogen-fixer, colonising effectively landslips and other such sites. Thus there is a need to have decentralised laws which effectively consider local needs, system-attributes and participatory approach.

The other aspects that need to be addressed include: poaching, over-exploitation of medicinal, aromatic plants and lichens, free grazing, extreme fragmentation of vegetation, degradation of forests outside protected areas, lack of inter-state cooperation, and impact of global warming, which perhaps has already begun to affect the Himalayan biomes. Many of the issues listed above are interconnected. **A positive step in any one area may bring about favourable results in many other areas.** For example, to facilitate women's participation it is important to reduce the burden of daily workload by providing labour saving devices, developing resources to meet the needs of organic agriculture next to homestead and empowering her constitutionally. This one step may lead to the improvement of forest conditions, child health and enterprise development. By breaking the cycle of low-quality cattle and low-quality fodder, we can improve forest regeneration as well as the people's economy. There is a need to educate people to bring about a change in attitude. Making people to "respect other species" and value the life-supporting services that natural ecosystems give, warrants a deeper understanding of the issues that confront humans. The exercise of bringing about the necessary cultural changes should, perhaps, begin with the decision makers.

PART I

The Ecoregion-specific Approach

Western Himalayan Ecoregion with which we are concerned here is one of India's premier regions still having some of the major ecosystem types. In a way it is India's only region that combines snow, alpine meadows and forests of a great variety. This is intimately connected with the one of the greatest plains on the face of the earth that provides food for about half a billion people – the Gangetic Plains. In this report we have not only focussed on the biodiversity of the Western Himalaya but also on the services that emanate from the region through geo-ecological processes. The region consists of three border hill states of India, namely, Uttaranchal, Himanchal Pradesh and Jammu & Kashmir. This is also the region through which different civilisations entered into the North India in the past until the British came, and gave cultural diversity that is a unique feature of the present India. In this regard we have kept in view the mountain and plains connections

The NBSAP exercise of India is one of the largest exercises of its kind in the world. We are glad that we are a part of it and have contributed to it. The main emphasis in our exercise of preparing SAP for the Western Himalayan Ecoregion is on seeking inputs from all the concerned people including those living in villages, representing Gram Panchayats, youth groups, social workers, foresters, academicians, elected members, policy and decision makers, directors and scientists of relevant institutes, etc. Since we were concerned with an ecoregion and already activities were going on at State and Sub-state levels, we did not conduct Peoples' Hearings or Village Level Sampling, instead we depended on inputs from knowledgeable persons, NGOs and other organisations who have developed, synthesised and crystallised their ideas based on field information involving all sections of the hill communities. However, wherever possible and where required we approached the people to improve our understanding. Our main strength was that the members of the WHER group have developed their ideas by living in the region and doing region-specific researches and analysing them in context of all possible national and global connections. Some of them have experience of more than two decades of working in Western Himalaya. Therefore, this output is not merely of the present exercise, but reflects the long experience of working in and on the region.

1. Description of activities undertaken

a. Meetings/ Workshops

i. Of Ecoregion members at Dehradun on 2-3 December 2000 that marked the beginning of NBSAP Process for the WHER

ii. Of Sub-groups of Ecoregion members

iii. Of Co-ordinator and some members of the group with key persons having knowledge and field experience in the required area

iv. Meetings with forest personnel and others working in areas related to forests from time to time.

v. With researchers of the region from diverse backgrounds

vi. Interaction with different NGOs and elected members of the region

vii. Two-day meeting of ecoregion members with academicians, foresters, social workers, NGOs, students, scientists of GBPIHED, Almora at Nainital.

viii. Participation in the North-Zone Meeting of NBSAP at Chandigarh.

ix. Attended village-representing meetings.

x. Visits to villages to develop first hand knowledge.

xi. Attending Ecotourism Workshop at Joshimath.

xii. Meeting organised in Srinagar (J&K) on 26 and 27 October by Dr. Rahul Kaul.

xiii. Making relevant people familiar with ideas developed – this included people dealing with law and judiciary including the Chief Justice of India, research groups, directors of institutes, press, teachers and corporates.

b. Routine exchange of ideas and other inputs within and outside the group.

c. Utilisation of published material in form of articles, reports, journals and books.

d. Attending workshops and symposia relevant to BD of WH.

e. Making relevant presentations in select symposiums (six symposia/seminars in the span of one year relating to the issues of biodiversity) to improve understanding and crystallise ideas.

f. Field visits to different areas.

g. Analyses and synthesis based on information generated in the relevant areas over the years from various sources.

h. Seeking inputs through newspapers.

i. Holding discussions with research community of Kumaun University.

j. Inviting suggestion from the relevant people.

k. Participation in the Northern Region Workshop at Chandigarh.

2. List of outputs

Papers:

a. Minutes of the Meeting at Dehradun (2-3 December 2000)

b. A Case for Biodiversity Conservation in Western Himalaya – a paper in CHEA Bulletin, Nainital

c. Imbalance in the approaches of environmental conservation – an article in the process of development

d. Western Himalayan Ecoregion: A Profile

e. Biological Diversity of The Western Himalaya Ecoregion: A Sketch

f. Developing awareness through publishing articles in regional and national; newspapers.

g. The draft of SAP circulated to experts for comments.

h. A research paper published in Current Science, June 2002.

3. Preparation of the Plan

- **Gathering information/data**

a. Remote sensed maps showing vegetation cover, landuse, vegetation in the region, both entire region and state-wise have been provided by IIRS, Dehradun (Dr. P.S. Roy and Pawan Joshi have analysed the maps).

b. Magnitude of species richness in the region: plants by taxonomic groups – flowering plants and their major groups such as orchids, gymnosperms, pteridophytes, bryophytes, algae, lichens, fungi including mycorrhizae and mushrooms; by forms, such as trees, shrubs, evergreen and deciduous, herbs, lianas, macrophytes and phytoplankton; animals such as mammals, reptiles, birds and insects. Nearly 60% of work has been completed.

c. Diversity by affinities of taxa.

d. Community and ecosystem types and species richness and diversity associated with them (all possible groups considered) – data has been compiled wherever applicable.

e. Species diversity by uses such as medicinal plants and other non-timber forest products (NTFPs), including morels and aromatic plants.

f. Rare-endangered and threatened plants and other organisms and their habitats.

g. Nativity and endemism.

h. Wild edible plants diversity

i. Agri-diversity – crops, fodder trees

j. Knowledge level of diversity in community and its change from one generation to another.

k. **Identification and analysis of ecosystem services**. Examples are, carbon sequestration, water retention and flood control, soil formation, soil nutrient enhancement, transport of soil fertility, climate stabilisation, scenic beauty, recreation,

l. **Understanding scales of ecosystem services** – global (mitigating of problems of climatic change, across regions (soil and fertility transport)

m. **Understanding valuation, marketing and payment of services**

n. **Identifying key actors and expertise**

These may be categorised as below:

i. Governmental –
   - Forest Department
   - Agriculture Department
   - Fisheries Department
   - Pollution Control Board
   - District Administration
   - Various Regional and National Institutes located in the region, related to soil and water conservation, agriculture, environment and development, forestry, remote sensing, bio- and geo-resources, medicinal plants, wildlife, etc.
   - Armed forces
   - Educational institutions
   - PWD
   - Department of Animal Husbandry
   - Botanical Survey, Zoological Survey, Geological Survey, IIRS, etc.

ii. Government supported institutes such as GBPIHED Almora, universities, ICIMOD, etc.

iii. Non-Governmental –
   - NGOs
   - Self Help Groups
   - Academic and other Associations
   - Voluntary Organisations
   - Municipal Boards

iv. Biodiversity Dependent Communities–

- Van Panchayats in Uttaranchal
- Forest User Groups – such as those using medicinal plants or using oak leaves for tasar
- Mahila Mangal Dal – Women Welfare Group
- Gram Panchayats

v. Others

i. Corporate and Businesses

ii. Individuals such as Scientists and Environment Activists, Entrepreneurs, Academicians, Religious persons including Missionaries

iii. Peoples Representative such as Politicians, Social Workers, etc.

iv. Funding agencies, e.g. Ford Foundation, WWF, World Bank, Department of Environment and Forests, DST, DBT, State Governments

v. Judiciary

- **Soliciting participation and inputs from all key actors**

By reaching out by e-mails, post, press releases, articles in journals, attending relevant seminars and symposia, and telephonically besides personal contacts.

- **Assessing participation, inputs, reports, etc. for gaps in coverage**

After having studied the various aspects of BD and its conservational aspects and the existing policy and legal framework certain points that have emerged in general have been identified for the WH ecoregion.

Compared to Uttranchal and H.P., the level of recent information and knowledge about J&K is lower in all areas concerning biodiversity be it in literature or field knowledge, largely because of insurgency during the past several decades.

In general the knowledge about biodiversity across all actors including the experts is low in spite of the fact that Western Himalayan region is one of the most researched regions of the country. It is true

that precise data that one may require for developing plans are never achievable and the plan needs to be developed with whatever information is available.

Widespread lack of knowledge is likely to be a major hurdle in developing a realistic and an effective plan. For example, valuation of biodiversity and ecosystem services is notoriously unreliable when applied to issues with which people are unfamiliar or their understanding is low. Peoples' responses and preferences depend upon institutional context and the kind of exposure they have. Both institution context and exposure in general, have not been conducive to biodiversity conservation. This applies to all sections of society.

- **Identifying needs for capacity building**

The institutions that operate at village community and higher levels have been listed, and their strengthens and weaknesses are being analysed. Uttaranchal has a history of peoples' participation in forest management even though institutions were formally formed by government even in H.P. and J&K.

Himalaya and the adjacent Gangetic Plains - the Planet's Great Geoecological Feature

Himalaya and Gangetic Plains combine to make, possibly the greatest geoecological feature on the face of earth. They encompass a wide range of, combination of great wilderness and anthropogenic pressure density. These mountains of unusual massiveness occupying over 1 million km^2, have produced a distinctive climate of their own and influences the climate of much of Asia. They are often called the water towers of the subcontinent. Since they are still rising, and are still full of energy, their surfaces are extremely vulnerable to erosion and landslips, altering landscape and life continuously with little respite.

Macro level diversity features of Western Himalaya

1. India's region of forests, alpine meadows and snow (the Eastern Himalayan Ecoregion, EHE is not known for the later two).
2. High biodiversity and endemism.
3. Maintenance of crop diversity at a certain scale at farmers' level.
4. Oaks-centred biodiversity; oaks are the greatest natural ecosystem forming plants of the world, and support a great variety of life: mammals, birds, insects on acorns and leaves; web of life associated with oak galls; epiphytes particularly lichens and orchids; semi-parasites and birds they support; and fruiting fungi including mycorrhizae.
5. Predominance of evergreen forests with about one-yr leaf lifespan that include as widely different plants on *Shorea* (sal), *Quercus* (oak), *Pinus* (pines) and maple.
6. Species of great commercial values: *Shorea robusta* and *Cedrus deodara* are among the finest timber species of the world.
7. Wide ecological range because of relatively larger variation in altitude, latitude and rainfall and its seasonality.

Western Himalayan Ecoregion

The Western Himalaya Ecoregion (WHER) refers to the tract of the land that lies between 29 – 36° N latitudes and 74 – 81° E longitudes and covering an area of approximately 1,50,000 sq. km in the north India. This region is bounded by river Sharada (Kali) in the east, Salt range in the west, Nanga Parbat in the north-west, Bhabar belt in the south, and the Main Central Thrust of the Great Himalayan range in the north. The region extends over three hill states of north India *viz.*, Uttaranchal, Himanchal Pradesh, and Jammu & Kashmir (Fig. 1). Geographically this region forms a contiguous landmass with the Tethyan zone that lies in its north. However, for Ecoregional and Biogeography based conservation planning the rain-shadow zone (i.e. trans-Himalaya) that lies north of the Great Himalayan massif especially in Jammu & Kashmir and Himanchal Pradesh has been separated from this region. The region has a distinct biophysical setting and is well known for its biogeographic, geo-hydrological, eco-climatic, socio-cultural, and aesthetic values.

The hill states of WHE share international boundaries with Pakistan, China and Nepal. It covers 18% of geographical area of the national and participates in 50% of the forest cover supporting 40% endemic species to the Indian subcontinent. It represents the zone of transition between palaetropic and holoarctic kingdom. It is having a rich indigenous knowledge system with variation in geological, ecological, socio cultural and economic configurations providing a unique differential value to evaluate biodiversity and its senses.

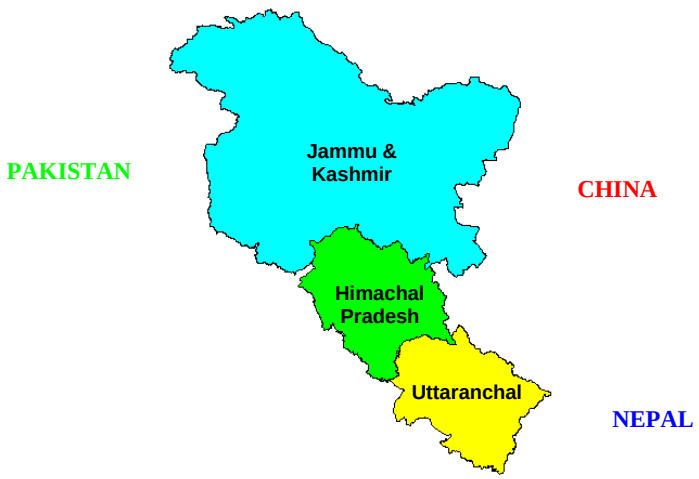


Fig. 1 Study Area - Western Himalayan Ecoregion

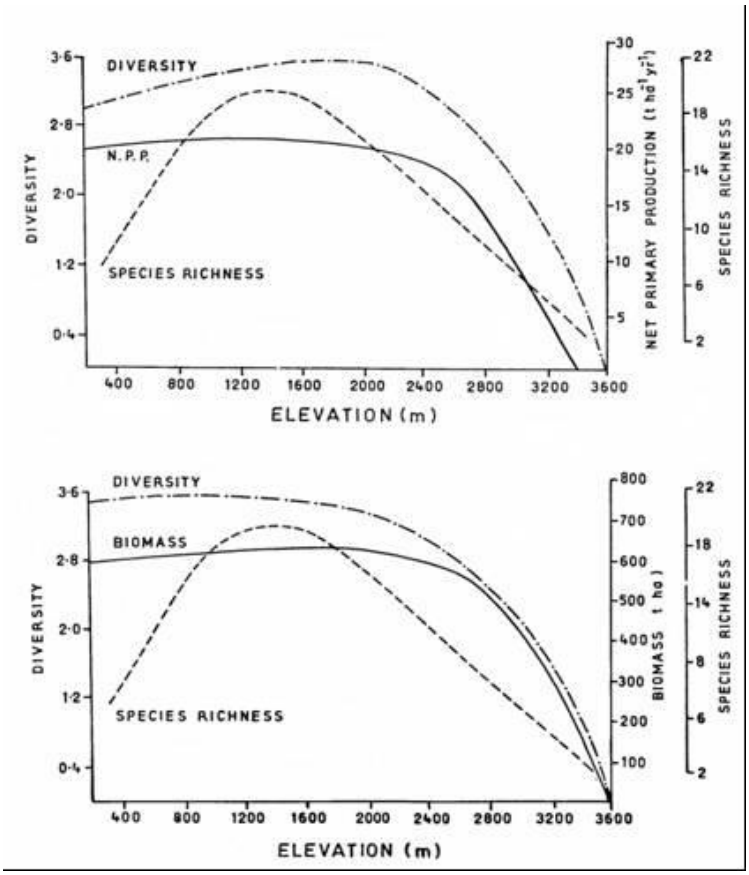
Key features of the region

The key features of the region from the conservation perspectives are given below:

i. *Biogeographic values:* WHER lies at the junction of two major biogeographic realms *viz.*, Palaearctic (Northern), and Indo-Malayan (south-eastern). In addition, it is strongly influenced by Mediterranean and Indo-Chinese sub-regions. As a result, it exhibits a great deal of intermingling of floral and faunal elements from the adjoining regions. Creation of new habitats, land bridges and changes in the biophysical features along with its orogeny have paved way for evolutionary convergence and divergence. Species which immigrated into this region during the geological past evolved into distinct ecotypes. Rodgers and Panwar (1988) have recognized two biogeographic provinces within this region, *viz.*, the North-west Himalaya (2A) and the West Himalaya (2B) separated by Sutlej river.

ii. *Varied eco-climatic zones*: Unlike other sectors of the Himalaya, the WHER is aligned in a general NW-SE direction representing about 8 degrees of latitudes and different eco-climatic zones. The altitude of the region varies from 300 m to over 7800 m asl (highest peak being Nanda Devi 7817 m). The major climatic zones include the sub-tropical, warm temperate, cool temperate, alpine and Aeolian zones. These zones are further influenced by peculiar physical features such as Bhabar and Doon systems of foot-hills, the broad inter-montane river valleys (e.g., Someshwar – Bageshwar, Gairsain, Kullu, Palampur – Dharmshala, Srinagar - Kashmir), parallel series of mountains *viz.*, Dhauladhar, Pir Panjal, and the Great Himalayan range. The climate of this region is often referred as extra-tropical mountain type that separates this region from the Eastern Himalaya, the latter being close to the tropical region and strongly influenced by monsoon. The effect of monsoon becomes less pronounced in the WHER. There is a great variation in the annual and diurnal temperature in this region due to continental effects. Much of the WHER receives a considerable proportion of the precipitation during winter season from the Western Disturbances (unlike the eastern region). This results in the

greater amount of snowfall. The region not only shows sharp gradient of climate along the south – north direction (altitudinal), but also along a horizontal (longitudinal) plane.



Figs. 2a (upper) & b (lower) Pattern of tree species diversity (Shannon Wiener Index), tree species richness, biomass and productivity (NPP) along an altitudinal transect of the Western Himalaya (each curve represents the upper limit of the values)

iii. *Hydrological importance*: WH is the region of great relief features and hydrological significance. This region forms the source, and major catchments of mighty rivers such as Indus, Sutlej, Ganga, Yamuna, Sharada and their numerous tributaries, which form the life line for over 300 million people in the north India including Indo-Gangetic plains. Even the Brahmaputra originates within a distance of less than 150 km from the northern boundary of WHER. While in the Eastern Himalaya the glaciers hardly descend below 4000 m, in Uttaranchal region of WH these may descend as low as 2800 m.

Presence of extensive glaciers and snowfields strongly govern the hydrology and climate of the region. Therefore, the duration and nature of surface flow available to the rivers of this region are quite different from the Eastern Himalaya. Besides, this region is known for a large number of natural lakes (both glacial and non–glacial) that make the landscape features its ecology all the more interesting. Kashmir and Naini Tal districts are particularly known for a large concentration of high altitude lakes.

iv. *Area of rich palaeo-ecological history*: According to the Palaeo-climatologists the WH has undergone a large number of changes in its relief features and ecology in the recent and sub-recent times. Such drastic changes are not known from the eastern region. For example, river Yamuna was formerly a tributary of Indus and flowed in the south-westerly direction till it changed its course to south-easterly direction and became a tributary of Ganga. **Two of the rivers *viz.*, Sutlej and Indus predate the origin of the Himalaya and their courses have witnessed the various phases of Himalayan orogeny**. The changes in the floral and faunal elements since the final phase of Himalayan uplift are also many. The fossil evidences indicate that a significant proportion of this region was under tropical wet evergreen forests at the beginning of Miocene. Several fossils of palms such as *Trachycarpus ladakensis*, *Livistonia* sp., *Palmoxylon*, members of Dipterocarpaceae (e.g., *Gluta, Anisoptera*) and Ebenaceae are reported from the region. More recent period has witnessed local extinction of broad leaved species (e.g., species of oaks from Kashmir valley). Such changes are said to be due to change in the climate as well as anthropogenic disturbances.

v. *Region of evolution and radiation of several taxa:* Despite its nature as a biogeographic link between the major realms, the WHER has served as a centre of evolution for several taxa and biotic communities. This is largely due to creation of new habitats subsequent to final phase of Himalayan uplift and formation of insular pockets within. **The most important taxa, which have evolved and radiated within this region include Leguminosae, Polygonaceae, Poaceae (Gramineae), Berberidaceae (Genus *Berberis*),**

Geraniaceae (*Impatiens* spp.) Acanthaceae (Genus *Strobilanthus*), and Scrophulariaceae (Genus *Pedicularis*) among the flowering plants. Among the faunal communities the family **Caprinae (wild sheep and goats) have successfully radiated in this region.** The region supports **over 4500 species of angiosperms, over 20 species of Gymnosperms, 350 species of Pteridophytes, 985 species of Bryophytes, 550 species of Lichens and a large number of algae and fungi** (exact number not known). Many of these species fall under the **neo-endemic** and palaeoendemic or relict categories. The region falls under the Endemic Bird Zone (D02) according to the Bird Life International.

vi. *The region of great cultural and historical importance*: The WH provided the gateway for the early Aryan invasion to India. This was followed by several military invasions and explorations. Therefore, the region assumes a special significance of being the area of oldest recorded human history. The region has, since then, experienced a great deal of cultural and ethnic changes influenced by the adjacent high mountains as well as plains. While Kashmir had been the favorite resorts for most of the Moghul kings, other parts such as Himanchal Pradesh and Uttaranchal were greatly favored by the British rulers and other administrators largely due to scenic beauty, ambient climate and proximity to Delhi. The influx of national and international tourism has been at rise incessantly till date and it is likely to increase in the near future. The region also represents an unique admixture of ethnic and cultural diversity comprising Hindus, Punjabis, Muslims and Buddhists. **A large number of religious shrines have been established in the region**, which play key role in retaining the cultural identity of the various ethnic groups. Local communities, the Bhotyan belong to Indo-Mongoloid ethnic race and have traditionally depended on an agro pastoral economy. It is extremely rich in terms of natural resources and biological and cultural diversity.

vii. *The region of rich agro-biodiversity*: The rich cultural and socio-political history of the region has led to adoption of a rich landuse practices and retention of a large number of domestic crops and animal races. **Several**

varieties of rice including *Basmati* from Doon Valley and Jammu, drought hardy varieties of barley, amaranths, hill millets, buck wheat, French beans, saffron, etc., have been the specialties of this region. Several horticultural crops such as Litchi, walnut, chestnut, hazelnut, and apricot have become peculiar products of many parts. Similarly, several domesticated animals and local breeds such as Bhotiya dog, Chhumurti horses of Pin Valley, Yaks, Dzo / Dzomos (cow – yak hybrids), donkeys, sheep and goats are of high conservation values.

viii. *Wild genetic and ethnobiological resources*: Man, in the western Himalayan mountains have explored and exploited much more wild genetic resources compared to the east. The long history of exploitation has also resulted in the accumulation of ethnobiological knowledge. A considerable number of useful plants are reported from this region, **the most important group being the medicinal plants.** The alpine region of the WHER is particularly rich (perhaps richest in India). Over exploitation of these plants have resulted in the local extinction of several taxa and this aspect has become one of the important issues of biodiversity conservation in the region.

ix. *Environmental sensitivity:* The Himalayan region as a whole is geologically young and tectonically active. Steep slopes, unconsolidated soil and ill planned developmental activities make it all the more fragile. The level of human exploitation is especially high in the WHER, where rapid conversion of protective ecosystems into productive and urban-industrial ecosystems have become major cause for concern among the environmentalists. Several ecologically sensitive zones can be identified in the region, which would need intensive care and continuous monitoring. It is pertinent to mention here that effects of larger environmental maladies such as global warming could be easily studied and monitored in this region

x. *A well researched region:* The WHER is a researched ecoregions in the country with potential to build up further research opportunities. The baseline information exists on various parameters of environment, floral and faunal diversity. The forest ecosystems of this region are best documented in the

country. Research on this aspect has proved that the temperate forests of this region have many tropical characteristics (especially in the eastern part of WHER) with predominance of evergreens having 1 – year leaf span. This uniqueness is of significant regional and global importance. The region also has a well recorded history of participatory management of natural resources. This is an added advantage, which would be useful for formulation of effective conservation plans.

Based on the above considerations it can be argued that WHER signifies one of the most important conservation areas in the country. In terms of overall diversity (variability of ecosystems, genes, species and their functioning), this region is as important as the Eastern Himalaya and hence should be designated as important hotspots of Biodiversity in the country.

1a. Geological Features

Having got isolated nearly 80 million years before the present (BP) from Madagascar, the Indian plate moved 4,000-5,000 km north towards Asia, and collided with southern Tibet some 40-50 millions yrs BP. India continues to penetrate into the rest of Asia at the rate of 4-5 cm per yr even today. In the process of collusion between the Indian plate and the Asian plate, there occurred shaving off of some of the crusts of Indian lithosphere. These shavings constitute Himalaya. There are two great fault lines separating the slices that resulted during the movement of Indian plate into the remaining Asian plate, separating Himalaya into the greater Himalaya where, snow-clad, sharp peaks can easily exceed 5,000-6,000 m of altitudes, the lesser Himalaya, generally 2000-5000m high with gentle topography, and the Siwaliks, the lowermost and youngest mountains. Named after Shiva the Hindu God of destruction, the Siwalik hills contain conglomerate of pebbles boulders and other fragments, representing outputs of the processes involving extremely high energy release. That the Gangetic basin remained wide and shallow in spite of overriding Himalaya clearly indicates how strong is the Indian plate. The plate provided a kind of bedding material for the formation of, possibly the most fertile and robust plains of the world.

These youngest and loftiest of the mountains are still rising, and are unstable and susceptible to landslips and other mass movements. The accumulating stresses within the crusts are manifest in recurring earthquakes throughout the subcontinent, and the highly shattered and sheared nature of rocks, including those roofing slates, a square meter of size with a few centimetres in thickness used traditionally in the typical Himalayan houses.

1b. Major properties of forest ecosystem and trees

The ecological variation associated with altitude is equivalent to a latitudinal displacement of 5000 km. It is the rise of Himalaya, beginning nearly 50-60 million years ago that not only led to establishment of the summer monsoon climate of Asia, but also a climate that has maritime elements, despite continental location: winters are mild and humidity is high round the year. The lapse rate of mean annual temperature, 4.6°C per 1000 m rise in altitude, is relatively moderate. Because of this forest cover extends beyond 3000 m altitude. The influence of these can be seen in several ecological features. Some examples are: (i) round the year cultivation of crops in plains and up to 2000 m in mountains; (ii) occurrence of high biodiversity and of forests with large biomass, 500 t ha^{-1} up to 2600 m altitude (Figs 2a &b; in temperate latitudes, plants may not occur above 1500 m altitude); (iii) evergreen trees which replace all their leaves annually as do deciduous species but maintain photosynthesis round the year; (iv) a pine which temporarily look like deciduous species during summers (some US pines have leaf lifespan up to 10-12 yrs); (v) a maple which is evergreen (people in the West would never believe, as all other maples are deciduous); (vi) tree rhododendron (genus is otherwise shrubby); (vii) a cherry which flowers in autumn (cherries are known flower in spring elsewhere), and (viii) ecosystem properties, even in sub-alpine altitudes resembling those of tropical ecosystems in certain parameters. For example, the turnover time of organic matter and nutrients (1.7 – 2.4 yr) are closer to those of tropical rain forests (0.4 – 2.4 yr) than the forests of the temperate regions (17 yr). The natural forest productivity is far more than that of crop fields that replace them (Zobel and Singh 1997).

Naturalist and biologist, neither of the west nor of Indian plains are familiar with the Himalayan oaks (*Quercus* spp.) which make extensive forests above 1500 m altitude is much of the over 2000 km wide east-to-west arch. These oaks support a great variety of wildlife, for soil rapidly enabling Himalayan farmers to sustain the fertility of their croplands, and contribute to water retention and spring life.

Through geological time, warm and wet climatic periods have alternated with cold and dry ones. Along with the rise in maximal altitude, from about 2500 m in the mid-Miocene to more than 8000 m at present, such climate changes (four glaciations occurred during the quaternary alone) have caused species extinctions and facilitated immigration of taxa from surrounding regions. The climatic cycles and rises in mountains produced oscillation in the altitudinal range of plants and animals, and to their isolations and migration. Plants of several taxonomical affinities occur in Himalaya - Malayaens, South-eastern, Palaearctic, and Mediterranean. But of all features, high endemism (organism which do not occur outside the area of occurrence) of species is most notable. Nearly 40% of India's endemic plant species occur in Himalaya, occupying only 18% of the area. Two of the major biodiversity hotspots of the world are located in the Himalayan belt.

2. Highland Ecosystems Services and Connections

The connections between high mountains with snow-clad peaks and glaciers, and the alluvial plains through snowfed rivers, like Ganga, Bramhaputra and Sindhu are very important both in ecological and social terms. The deep river gorges provide difficult access routs from outer to inner Himalayan ranges of the Tethys Himalaya, and have contributed to expansion of political, religious and cultural dimensions of India.

The ecosystem services that Himalaya provides are operative at regional, inter-regional, and global scales. Carbon sequestration by Himalayan forests and the medicine system that has developed from the Himalayan herbs, as examples are services of global nature, and utilization of forest litter and soil for managing cropland fertility by the Himalayan cultivators is of regional nature. But the special are the services that Himalayan forests provide to the Gangetic plains. This includes replenishment of soil, water and nutrients of the croplands of the plains in a regulated

way. On this depends the agricultural productivity that enables country to provide food for over a billion people, without heavy inputs of chemicals. You dig out soil several feet deep, yet you find soil. The land used for brick making is restored soon without much efforts and starts producing foodgrains. The 400 million inhabitants of Gangetic plains do not know what soil erosion is and what a dust bowl is, a term familiar to Americans in 1930s. This primarily shows the role of ecosystem subsides of Himalaya.

The **services also include cultivation of native crop varieties (representing a kind of management of genetic diversity) by the Himalayan farmers**, scenic beauty, and wilderness that attracted sages, thinkers, and religions people, shaping them with philosophical elements. The island-like situation led to differentiation of numerous cultural groups and centres, and to their coexistence for centuries.

There is **a need to take economic measures to enable highlanders to conserve forests that serve not only hill people, but also the entire humanity.** Mechanism of payment needs to be developed for all the Himalayan services. If effective action is not taken, much of the Himalayan forests might be lost soon. Shorn of forest cover, the fragile and unstable mountains would supply mainly coarse geological material, with little biologically produced soil that nurses crop in the adjacent plains. Valuation of services rendered by Himalayan ecosystems is a subject part of science as well as socio-political regime. To keep the about 638,000 km^2 large Gangetic plain fed adequately with the Himalayan services is important. Much of the forests in the mountains are losing their geoecological strands, and thus are losing services values. They need to be restored before scale becomes too high to tackle. Many Himalayan areas are in turbulence, the socio-political factors causing them vary, but all have one common feature, the mountains.

3. The States of Western Himalaya

The state of Jammu and Kashmir located in the far north of the Indian Republic, is a mountainous area in the north-west Himalayas that shares international boundaries with Pakistan in west, China in the north and Tibet in the north east. The state is having Punjab and Himanchal Pradesh as its neighbouring states in the country. The major three territories, Jammu, Kashmir and Ladakh differ in terms of climate, physiography, ethics and culture. All the three regions experience different climatic patterns. Cold desert like condition prevails in Ladakh, and alpine, temperate and subtropical type in rest of the state. The four distinct seasons are spring (March – May), summer (June-August), autumn (September- November) and winter (December – February). The average maximum and minimum temperature is 31°C and 18°C in July and 4°C and 2°C in January except in Ladakh where maximum temperature is 30°C and minimum temperature –50°C. Annual rainfall in the state varies from 1000-1550 mm except in Ladakh where the precipitation is low and varies from 100-200 mm. Srinagar receives only about 700 mm of rain annually because of the obstructive influence of Pir Panjal range. The climate has some Mediterranean content, as winter rains are substantial. The sub-tropical climate of Jammu is characterised by a hot summer, and monsoon rains during June-August. January is the coldest month of the year though the temperature never touches zero. There is an abrupt rise in temperature March onwards and in May reaches 44°C during June (Anon., 1997). The region supports diverse vegetation types and species diversity. The recent years have seen excessive anthropogenic pressure on forest cover and its quality.

Himanchal Pradesh, a part of Western Himalayas is situated between 30°22’44” N to 33°12’40” N Latitude and 75°45’55” E to 79°04’20” E longitude covering an area of 55,673 sq km at an altitude of 247m to 7,000m from mean sea level (msl). The state surrounded by Jammu & Kashmir in the north, Punjab in the west, Haryana in the south, Uttaranchal in the Southeast and to China in the Northeast. The geographical area is approximately 55,672 sq km. From the southwest to the northeast the state changes from hilly to mountainous. In the south, the state is formed by the Siwalik, the foothills of the Himalayas at 1,000 m. In the northeast, the outer ranges of the Himalayas *viz.* Dhaulashar and Pir Panjal renges at 6000m

surrounds the sate. To the northeast of these ranges the region of the Trans Himalayas start, which is high and barren region. The valleys of Lahaul and Spiti fall into this region, with mean altitude of 4,000m at the valleys.

Due to large differences in altitude and precipitation, the vegetation types in this region range from sub-tropical to alpine. In the lower regions, the vegetation type is sub-tropical. The temperature in this part is high and it receives a high amount of rainfall, especially during the monsoon. The prevailing forest types in this part of the state are mainly sal forests and mixed deciduous forests. On the southern slopes of the outer ranges of the Himalayas, the temperature is low having even zero degree in winters, creating a temperate climate. Temperate forests are consisting of temperate mixed deciduous coniferous forests, pine forests, deodar forests and oak forests. These areas receive a very large amount of rainfall in the monsoon, because of convection of the monsoon clouds that come from south. In higher ranges climate changes into an alpine climate with a very dry climate and often temperature below zero in winter. Because of these low temperatures and the very small amount of precipitation most of this region is barren.

The state Uttaranchal shares the international boundaries with Tibet, China and Nepal and with the state Himanchal Pradesh, and Uttar Pradesh in India. The area extends from the natural divide of the Kali River in the east bordering Nepal to Tons-Pabar Valley in the west separating it from Himanchal Pradesh and the foot hills of shiwalik to differentiate it from the Uttar Pradesh. The glaciers in the high hills are the source of the Yamuna and Ganges. Garhwal and Kumaon are the two main cultural and political divisions of Uttaranchal. The region can be divided into three physiographical zones *viz.* Northern Zone (3000 – 7600 m), Mid Zone (2000 to 3000 m) and Southern Zone (600 to 2000 m). The geological units from south to north are Tarai and Bhabar, Shiwalik, the Lesser Himalayas, the Great Himalayas, the Teths, and Tibatal Himalayas.

Orographically very diverse climatic conditions prevail within the area due to large variations in altitudes. The mean annual temperatures decline at the rate of 0.46°C with 100 m rise in altitude. Slope, aspect, vegetation cover and soil conditions mainly control the microclimatic conditions. Along the foot hills and broad valleys

summer and rainy seasons are quite warm, where as, higher elevations are characterized by chilling and severe winter and moderate to cool summer season. The area can be divided into subtropical, temperate and alpine climate types. The region is influenced by the south west monsoon. It starts at different locations between second to fourth weeks of June. Occasional rainfall is common prior to on set of rainfall (Anon, 2000c).

4. Land Cover Pattern in Western Himalaya

According to the J&K Forest Report 1999, of the Forest Survey of India, the recorded forest area in the state occupies only 20,441 sq km *i.e.* 9.2% of its area. The area analysed in the present study is about 204,571.84 sq km as the data set for the area adjacent to Pakistan cannot be procured for cloud/snow free months. The available months were either totally cloud/snow covered, or were found to be good for nothing for land cover estimation. The forest cover estimated in the present study is worked out to be 14% of the studied geographical area (Fig. 3) which is perhaps better than the limited datasets used by FSI, *viz.* Nov. – Dec. 1996 and Sep. – Oct. 1997 that made an underestimation of high altitude forest cover (Anon., 1999). The National Forest Policy, 1988 says Hill regions should aim at a forest cover of 66% against 33% the prescribed figure for the plain regions of the country.

The geographical area of HP is 55,573 sq km. According to the State Forest Report, 1997, of the Forest survey of India, the actual forest area in the states occupies only 12,521 sq km *i.e.* 22.5 % of its area. The recorded forest cover is 35,407 sq km, which is 63.60 % of geographical area (Anon., 1999) (Fig. 3).

The geographical area of UA is 53,485 sq km. According to the State Forest Report, 1997, of the Forest survey of India, the actual forest area in the state occupies only 23,360 sq km *i.e.* 43.49 % of its area. The National Forest Policy, 1988 says Hill regions should aim at a forest cover of 66% against 33 % the prescribed figure for the plain regions of the country. The estimated forest cover in the present BSAP is 42.3% (Fig. 3).

Forest types occurring in the Western Himalayan Ecoregion (according to Champion and Seth, 1968)

Class	Type	UA	HP	J&K
3C/C2(a,b)	Moist Siwalik and moist bhabar Sal	+	+	-
4C/FS2	Sub-Montane hill valley swamp	+	+	-
5B/ C1(a)	Dry Siwalik Sal	+	+	-
5B/C2	Northern dry mixed deciduous	+	+	+
5B/DS1	Dry deciduous Sc.	+	+	+
5B/DS2	Dry savannah	+	-	-
5B/DS3	Euphorbia Sc.	-	-	-
5/E9	Dry bamboo brake	+	+	+
5/IS2	Khair- sissu	+	+	-
6B/C2	Ravine thorn	+	-	-
9/C1(a,b)	Lower or Siwalik and upper or Himalayan chir- pine	+	+	+
9/C1/DS1	Himalayan sub –tropical sc.	+	+	+
9/C1/DS2	Sub-tropical Euphorbia Sc.	+	+	+
10/C1(a)	Olea cuspidate Sc.	+	+	-
10/C1(a,b)	Sub-tropical dry evergreen	-	-	+
10/C1DS1	Dodonaea Sc.	-	-	+
12C1(a to f)	Lower Western Himalaya temperate	+	+	+
12C1/DS1	Oak Sc.	+	+	+
12C1/DS2	Himalayan temperate secondary Sc.	+	+	+
12C2(a to c)	Upper West Himalayan temperate	+	+	-
12/C2 (c)	Temperate deciduous	-	-	+
12/E1	Cypress	+	+	+
12/DS1	Montane bamboo brake	+	+	-
12/DS2	Himalayan temperate park land	+	+	+
12/DS3	Himalayan temperate pasture	+	+	+
12/1S1	Alder	+	+	+
12/2S2	Riverain blue-pine	+	+	+
12/2S1	Low- level blue-pine	+	+	+
13/C1	Dry broad leaved and coniferous	+	+	+
13/C2 (a,b)	Dry temperate coniferous	+	+	+
13/C2/DS1	Pohu Sc.	-	-	+
13/C2/DS2	Dry temperate Sc.	+	+	+
13/C3	West Himalayan temperate deciduous	+	+	+
13/C4/I3/IS2,I4/2S1	West Himalayan high-level dry blue- pine	+	+	+
13/C5	West Himalayan dry Juniper	+	+	+
13/1S1	Hippohae/ Myricaria	+	-	+
13/1S2	Populus/ Salix	+	+	+
14/C1(a, b)	West Himalayan sub-alpine birch/fir	+	+	+
14/C2	East Himalayan sub-alpine birch/fir	+	+	+
14/DS1	Sub- alpine pasture	+	+	+
14/1S1	Hippophae/ Myricaria brakes	+	+	+
15/C1	Birch/ Rhododendron Sc.	+	+	+
15/C2	Deciduous alpine Sc.	+	+	+
15/C2/E1	Dwarf Rhododendron Sc.	+	+	+
15/C3	Alpine pastures	+	+	+
16/C1	Dry alpine Sc.	+	+	+
16/E1	Dwarf Juniper Sc.	+	+	+

4.1 Forests of Western Himalaya

The forests of Kashmir are characterised by coniferous (pine, silver fir and spruce) forest, Himalayan Temperate forest (broadleaved), sub-alpine Forest and Tropical Dry Deciduous Forest (Table 1).

4.1.1 Himalayan Temperate forest

The healthy vegetation is in the beds and banks of streams and canals. In the Pir Panjal region the forest occurs between 2000m to 3200 m. The forest can be further classified as 'moist temperate' or 'dry temperate' types, but the present study has limitations to discriminate it because of coarse resolution which is unable to trace ground configuration. The pine zone extends from 1600 m to 3000m. *Pinus wallichiana* (around 2800m), *Cedrus deodara* (1800-2800m) and *Abies pindrow* (2500m) are important conifers. The deodar resides at an altitude of 1800 m to 2600m.

4.1.2 Sub-alpine Forest

The sub-alpine forest consists of *Rhododendron, Juniperus, Betula* and *Abies*. The low linings are with blue pine forest (*Pinus wallichiana*) and deciduous scrub.

4.1.3 Tropical Dry Deciduous Forest

The dry and mixed deciduous type constitutes the vegetation of Punjab Plains. The forest belt comprises *Acacia forest, Bauhinia variegata-Oogeinia* forest, Lanneas, coromandelical – Hymenodictyon oexcelsum forest, Dodonaea scrub, Mixed semi-deciduous forest and Subtropical Pine (*Pinus roxburghii* 'chir') forest.

Excessive encroachment (cultivation and colonisation) has reduced the forest to few relict packets. Major forest produce is timber and fuelwood. Due to excessive biotic pressure, heavy exploitation for the purpose of timber, fuelwood extraction, grazing and other local uses, the forest cover has been reduced and many areas are degraded. Efforts are underway to restore and rehabilitate degraded areas by bringing them under massive afforestation, social forestry and fuelwood/fodder development programs.

Table 1 Forest Cover/Types in J&K– Mapped *vis-à-vis* Champion and Seth (1968).

Cover Types (Mapped in Present Study)	Forest Types (Champion and Seth, 1968)
Himalayan Temperate Forest	Himalayan Moist Temperate Forest
	Himalayan Dry Temperate Forest
Coniferous Forest	Sub Tropical Pine Forest
	Sub Tropical Dry Evergreen Forest
Sub Alpine Forest	Sub Alpine Forest
Tropical Dry Deciduous Forest	Tropical Dry Deciduous Forest
Alpine Scrub/Meadows	Moist Alpine Scrub
	Dry Alpine Scrub

The forest of Himanchal Pradesh is characterised by Temperate Conifer and Mixed Forest (Himalayan Moist & Dry Temperate Forest), Sub Alpine Forest, Tropical Forest (Tropical Moist Deciduous, Littoral & Swamp and Sub Tropical Pine Forest) and Broad Leaved Forest (Tropical Dry Deciduous & SubTropical Dry Evergreen Forest) (Table 2).

4.1.4 Himalayan Temperate forest

The healthy vegetation is in the beds and banks of streams and canals. The forest can be further classified as 'moist temperate' or 'dry temperate' types, but the present study has limitations to discriminate it because of coarse resolution. The further classes of Himalayan Temperate Forest in the present study are Temperate Coniferous Forest and Temperate Mixed Forest. The Coniferous forest consists of Deodar (*Cedrus deodara*) as dominant species and Fir (*Abies pindrow*), Spruce (*Picea smithianan*), Chir Pine (*Pinus roxburghii*) and Blue Pine (*Pinus wallichiana*) as other species. Generally Deodar and Ban Oak (*Quercus leucotrichophora*) is found between 1700 m to 2500 m, inbuilted with Moru Oak (*Quercus himalayana*) and Kharsu Oak (*Quercus semecarpifolia*) which are mainly found around and above 2500 m. The Blue Pine is usually found between 2100 and 2500 m.

4.1.5 Sub Alpine Forest

The sub alpine forest constitutes of Rhododendron and Juniper with some shrubs of *Betula/Abies*. The low linings are with blue pine forest (*Pinus wallichiana*) and deciduous scrub.

4.1.6 Tropical Forest

In this zone the Pine forest is found called as Siwalik Chir Pine Forest at an elevation of 800 m. The dry and mixed deciduous type continues the vegetation of Punjab Plains. The forest belt comprises of Acacia forest and Bauhinia variety, mixed with semi-deciduous forest and subtropical Pine (*Pinus roxburghii* 'chir') forest.

4.1.7 Sub-tropical broad leaved

It is covering most of the area in the lower parts of the state not more than 1000m altitude. It mainly dominated by Sal (*Shorea robusta*) with *Dalbergia sissoo, Mallotus philippinenesis, Toona serrata* and *Accacia* spp. Some of the regions are occupied by Ban Oak (*Quercus leucotrichophora*). The region is having high temperature and high amount of rainfall.

Table 2 Forest Cover/Types of H.P. – Mapped *vis-à-vis* Champion and Seth (1968).

Cover Types *(Mapped in Present Study)*	**Forest Types** *(Champion and Seth, 1968)*
Temperate Conifer Forest	Himalayan Moist Temperate Forest
Temperate Mixed Forest	Himalayan Dry Temperate Forest
Sub Alpine Forest	**Sub Alpine Forest**
Tropical Forest	Tropical Moist Deciduous Forest
	Littoral & Swamp Forest
	Sub Tropical Pine Forest
Broad leaved Forest	Tropical Dry Deciduous Forest
	Sub Tropical Dry Evergreen Forest
Alpine Meadows/Scrub	Alpine Forest

The forests of Uttaranchal are characterised by Temperate Coniferous and broad leaved forest, with Tropical coniferous forest, Moist deciduous forest, Dry deciduous forest and Sub tropical sal forest (Table 3).

4.1.8 Temperate Conifer Forests

These forests are confined to higher elevations and include the communities of a number of high altitude broadleaf trees like *Cedrus deodara, Pinus wallichiana, Cupressus torulosa, Abies pindrow* and *Picia smithiana*. Occasionally a few broad-leaved trees are also found associated with the coniferous trees.

4.1.9 Temperate Broadleaved forest

These forests are confined to higher elevations and include the communities of a number of high altitude broadleaf trees like *Quercus leucotrichophora, Q. floribunda, Q. Semecarpifolia, Q. lanuginose, Aesculus indica* and *Betula utilis*. Himalayan Moist Temperate Lower Temperate, Moru Oak, Moist Deodar (Himalayan cedar), Temperate Mixed Coniferous, Temperate Moist Mixed Deciduous, Kharsu Oak and Oak-fir are the cover types in this class.

4.1.10 Tropical Coniferous (Pine) Forest

Pinus roxburghii is the single dominated species of this forest which covers most of the central region of the area. A few subordinate species like *Lyonia ovalifolia, Rhododendron arboreum* make their presence at a few locations. Sub-Tropical Pine Lower Siwalik Chir Pine, Upper Himalayan Chir Pine (above 2000m) Sub-Tropical Dry Evergreen Scrub Olea Scrub (lower western hills) and Upper Himalayan Chir Pine (above 2000m) are the dominant types found in this region. Most of this forest is used for grazing as it supports a good grass cover in most of the places.

4.1.11 Dry Deciduous Forest

The dry deciduous forest was found in the southern most part of the area on drier slopes and on the Bhabbar belt. Major tree species are found in these forests are *Holoptelia integrifolia, Dalbergia sissoo, Acacia catechu* and *Anogeissus latifolia*. Tropical Dry Deciduous Dry Siwalik Sal (dry exposed slopes), Dry Mixed Deciduous, Dry Bamboo Brakes (lower foothills) and Khair Sissoo (along streams) are the major cover types.

4.1.12 Moist Deciduous Forests

These forests are also dominated by *Shorea robusta*, with a higher contribution of associated species. These forests are found in the same altitudinal zone that of sal.

4.1.13 Sal Forest

The gregarious sal forests are limited in patches over the Shiwalik hills. The *Shorea robusta* is the main species of the forest. However, a few individuals of associated species are also found in certain localities. Tropical deciduous moist Siwalik Sal (Dehradun) and Moist Bhabar Sal (Ramnagar, Haldwani) are the major types. These forests are mainly confined below 1000 m altitude.

Table 3 Forest Cover/Types of U.A. – Mapped *vis-à-vis* Champion and Seth (1968).

Cover Types ***(Mapped in Present Study)***	*Forest Types* ***(Champion and Seth, 1968)***
Dry Deciduous Forest	Tropical dry deciduous forest
Moist deciduous forest	Tropical moist deciduous forest
Sal Forest	**Tropical moist deciduous forest**
Pine forest	Himalayan Subtropical pine forest
Temperate/subalpine broadleaf forest	Western Himalayan temperate forest
Temperate/subalpine Conifer forest	Western mixed conifer forest

4.2 Non-forest

The J&K region is almost treeless expanse. Due to scarcity of the precipitation the plants are generally found growing along moist river margins or in moist rock crevices. The alpine herbs grow in belts along the edges of melting glaciers and never spread to exposed slopes. The characteristic features of the vegetation are the cushion like habit of plants, which is an adaptation for cold dry winds and blizzards. About 60% of the population engaged in it directly or indirectly. Major crops are paddy, wheat and maize with barley, sorgahum and gram as minor ones. Inspite of the increasing demand and complex agricultural problems of the temperate and cold arid region of the state has forced to import large amount of food grains from other states. Cultivation of fruits and other horticulture crops has been practiced in this state over ages. The agroclimatic condition is well suited for cultivation of a large number of temperate and sub-tropical fruits of different varieties, *viz.*, mangoes, bananas, oranges, apples, cherries, pears, mulberry and apricots. The three rivers *viz.* the Tawi on which Jammu city stands, the Chenab and the Jhelum together with its tributaries waters the fertile Valley of Kashmir. The major water bodies Dal and Nagin. The lakes abound swampy lagoons and distinctive hydrophytic formations. The higher

ridges and upper reaches of the state are permanently snow covered *i.e.* glaciers. The foothills and high passes get covered with the seasonal snow falls. Some of the regions are have low lying clouds (Table 4).

Table 4 Forest types and other landuse statistics of Jammu & Kashmir (source: P.S. Roy and Pawan Joshi, unpubl.)

Land Use/Land Cover	Area (%)	Area (sq km)
Temperate Conifer Forest	3.79	7753.273
Temperate Mixed Forest	2.11	4316.466
Sub Alpine Forest	3.06	6259.898
Sub Tropical Forest	5.69	11640.14
Alpine Meadows	28.14	57566.52
Orchard	1.89	3866.408
Agriculture	5.24	10719.56
Valley Agriculture	3.5	7160.014
Water Body	0.62	1268.345
River Channel	0.18	368.2293
Snow	45.78	93652.99
Total	**100**	**204571.8**

Actual Area: 222235 sq km

The alpine meadows/scrub in Himanchal Pradesh is almost treeless expanse with few *Junipers*. Due to scarcity of the precipitation available the plants are generally found growing along moist river margins or in moist rock crevices. The alpine herbs grow in belts along the edges of melting glaciers and never spread to expose slopes. Some Mosses and Lichens were also found during groundwork. The characteristic feature of the vegetation is the cushion like habit of plants, which is an adaptation for cold dry winds and blizzards.

Orchard/agriculture consists of small fields mixed with scattered broadleaved species. The common plantation trees are *Eucalyptus, Acacia, Ficus,* jacaranda, mango *etc*. Besides trees there are many shrubs *viz. Parthenia*, *Lantana camara* and *Muraia*. The inbuilt agricultural fields are too small to be mapped out by this sensor. Major part of the population engaged in Valley Agriculture/Agriculture directly or indirectly. Major crops are wheat, maize and rice with barley, sorghum and gram as minor ones. Cultivation of fruits and other horticulture crops has been practiced in this state over ages. The agroclimatic condition is suited for cultivation of a large number of temperate and sub-tropical fruits of different varieties, *viz.* mangoes, bananas,

oranges, apples, sherries, pears, mulberry and apricots. The grass and shrubs with sparse trees cover the unused area. This is generally in the steep slopes of the hills and few plains. Most of the hills are with bare rocks classed as Barren. Some of the riverbeds are also considered in this class. The higher ridges and upper reaches of the state are mostly snow covered *i.e.* glaciers. The foothills and high passes get covered with the seasonal snowfalls. Some of the regions are have low-lying clouds (Table 5).

Table 5 Forest types and other landuse statistics of Himanchal Pradesh (source: P.S. Roy and Pawan Joshi, unpubl.)

Land Use/Land Cover	Area (%)	Area (sq km)
Temperate Conifer Forest	5.87	3268.005
Temperate Mixed Forest	2.41	1341.719
Sub Alpine Forest	4.27	2377.237
Sub Tropical Forest	2.84	1581.113
Broad Leaved Forest	1.76	979.8448
Alpine Meadows	8.32	4631.994
Orchard/Agriculture	7.51	4181.042
Orchard	4.88	2716.842
Agriculture	8.16	4542.917
Valley Agriculture	3.36	1870.613
Scrub	7.98	4442.705
Barren	8.67	4826.849
Water Body	0.52	289.4996
River Channel	0.89	495.4897
Snow	32.56	18127.13
Total	**100**	**55673**

The alpine herbs grow in belts along the edges of melting glaciers and never spread to expose slopes. They occur in small islands surrounded by forests from down below and barren rocks from the upper side. As we go towards west the size of alpine meadows become larger and continuous. Agriculture consists of small agricultural fields mixed with mainly broad-leaved species. The inbuilt agricultural fields are too small to be mapped out by this sensor. Major part of the population engaged in valley agriculture/agriculture directly or indirectly. Major crops are wheat, maize and rice with barley, sorghum and gram as minor ones. Cultivation of fruits and other horticulture crops has been practiced in very less amount in this state over ages. The grass and shrubs with sparse trees cover the unused area. This is generally in the steep

slopes of the hills and few plains. Some of the riverbeds are also considered in bare rock and sandy pebbles. The terrain of the sub-Himalayan belt is highly dissected by the transverse rivers. The notable rivers are Sharda, Deoha, Behgul, Kosi, Ganga and Solani etc. Except in the rainy season, in the large part of the year, most of the streams remain dry in which the water of small streams disappear. The higher ridges and upper reaches of the state are mostly snow covered *i.e.* glaciers. The foothills and high passes get covered with the seasonal snowfalls. Some of the regions are have low-lying clouds (Table 6).

Table 6 Forest types and other landuse statistics of Uttaranchal (source: P.S. Roy and Pawan Joshi, unpubl.)

Land Use/Land Cover	Area (%)	Area (sq km)
Temperate Conifer Forest	11.25	6017.063
Temperate Broad Leaved Forest	14.6	7808.81
Tropical Coniferous (Pine) Forest	10.13	5418.031
Moist Deciduous Forest	5.66	3027.251
Dry Deciduous Forest	1.3	695.305
Sub Tropical (Sal) Forest	1.05	561.5925
Alpine Meadows	12.78	6835.383
Scrub	6.62	3540.707
Plantation	1.9	1016.215
Agriculture	21.23	11354.87
Water Body	1.88	1005.518
River Channel	0.67	358.3495
Snow	10.93	5845.911
Total	**100**	**53485**

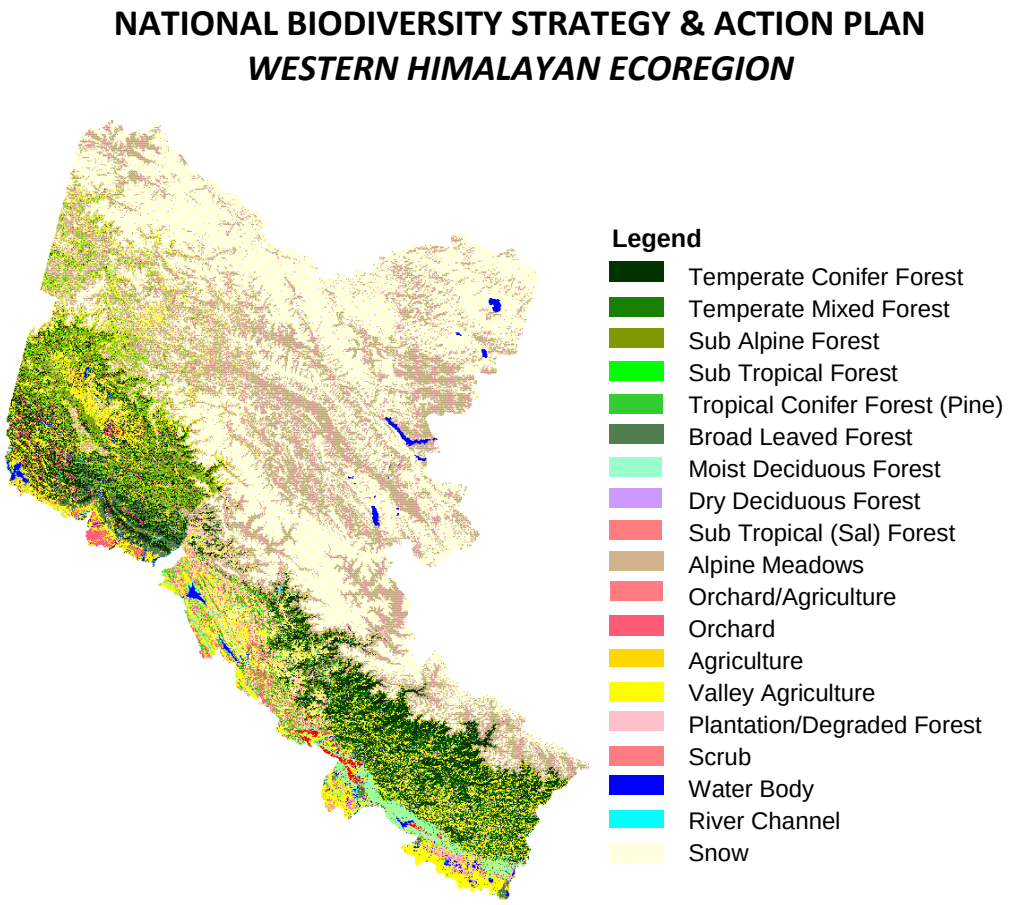


Fig. 3 Land Use/Land Cover Map - Western Himalayan Ecoregion (source: P.S. Roy and Pawan Joshi, unpubl.)

Table 7 Land cover/ use of Western Himalaya and its states considering Total Area of Western Himalaya. All areas in km^2 (developed by Dr. P.S. Roy and his group using remote sensing and GIS techniques) (managed cover includes cropfields and orchards; scrubs includes both natural and manmade).

	J&K	**% of total state area**	**% of total WHE area**	**HP**	**% of total state area**	**% of total WHE area**	**UA**	**% of total state area**	**% of total WHE area**	**Total**	**% of total WHE**
Forests	29969.78	14.65%	9.55%	9547.92	17.15%	3.04%	23528.05	43.99%	7.50%	63046.19	20.1%
Alpine Meadows	57566.52	28.14%	18.35%	4631.99	8.32%	1.48%	6835.38	12.78%	2.18%	69034.46	22.0%
Managed Cover	21745.98	10.63%	6.93%	13311.41	23.91%	4.24%	12371.09	23.13%	3.94%	47428.94	15.1%
Water bodies	1636.57	0.80%	0.52%	784.99	1.41%	0.25%	1363.87	2.55%	0.43%	3785.46	1.2%
Barren	0.00	0.00%	0.00%	4826.85	8.67%	1.54%	0.00	0.00%	0.00%	4826.95	1.5%
Scrub	0.00	0.00%	0.00%	4442.71	7.98%	1.42%	3540.71	6.62%	1.13%	7983.51	2.5%
Snow	93652.99	45.78%	**29.85%**	18127.13	32.56%	5.78%	5845.91	10.93%	1.86%	117627.17	37.5%
Total	**204571.84**			**55673.00**			**53485.01**			**313729.85**	
		100.00%	*65.21%*		100.00%	*17.75%*		100.00%	*17.05%*		100.0%

Actual Area of J&K: 222235.00

Table 8 Land cover/ use of Western Himalaya and its states considering Snow-free Area of Western Himalaya. All areas in km^2 (developed by Dr. P.S. Roy and his group using remote sensing and GIS techniques) (managed cover includes cropfields and orchards; scrubs includes both natural and manmade).

	J&K	**% of total state area**	**% of total WHE area**	**HP**	**% of total state area**	**% of total WHE area**	**UA**	**% of total state area**	**% of total WHE area**	**Total**	**% of total WHE**
Forests	29969.78	27.02%	15.28%	9547.92	25.43%	4.87%	23528.05	49.39%	12.00%	63046.47	32.1%
Alpine Meadows	57566.52	51.90%	29.36%	4631.99	12.34%	2.36%	6835.38	14.35%	3.49%	69034.86	35.2%
Managed Cover	21745.98	19.61%	11.09%	13311.41	35.45%	6.79%	12371.09	25.97%	6.31%	47429.21	24.2%
Water bodies	1636.57	1.48%	0.83%	784.99	2.09%	0.40%	1363.87	2.86%	0.70%	3785.48	1.9%
Barren	0.00	0.00%	0.00%	4826.85	12.86%	2.46%	0.00	0.00%	0.00%	4827.00	2.5%
Scrub	0.00	0.00%	0.00%	4442.71	11.83%	2.27%	3540.71	7.43%	1.81%	7983.55	4.1%
Total	**110918.85**			**37545.87**			**47639.10**			**196103.82**	

	100.00%	*56.56%*	100.00%	*19.15%*	100.00%	*24.29%*	100.0%

4.3 Demographic Background

Occupying 9.5% of the total geographical area of India (32,87,263 km^2) the Western Himalayan region accounts for only 2.4% of the country's population as per 2001 census (Table 9). The population density is distinctly lower in the mountains, the mean being 122 per sq km, compared to 324 per sq km for India as a whole. Within the WH region the density declines westward from Uttaranchal to J&K (Table 9) partly because of the fact that the easternmost state, Uttaranchal has a substantial proportion of the area in the densely populated plains and a considerable portion of J&K, particularly in Ladakh is scarcely habitable. At present while the decadal growth rate of J&K is markedly higher than that of the mean growth rates of the country, the other two states values are lower (Table 10). The sex ratio (females per 1000 males) of the WHE (Western Himalayan Ecoregion) is slightly higher and among the states it is relatively lower in the J&K than in other states. Interestingly within the ecoregion overall literacy is directly correlated with to sex ratio and population growth. The people who are more literate have a higher sex ratio as well as better population control (Table 11). J&K has a lower literary level than the mean for India, whereas HP & Uttaranchal have higher literacy level (Table 12).

Anthropogenic pressure on agricultural land in WHE is high, 5.2 persons per ha. Since land suitable for cultivation is scarce; people are forced to exploit steep slopes. Though hill farmers take conservational measures such as terracing, and applying organic manure, soil and nutrient loss associated with crop cultivation is quite high. More importantly, growing crops in hills is mainly a livestock-based activity. Animals are raised not only to carryout ploughing and other agricultural activities, but also for manuring crop fields, maintaining soil structure and promoting soil water retention. On average, about 5-7 animals (bullocks, cows, calves and buffaloes plus goats) per ha land holding is common. Through these animals hill farmers are able to exploit wild vegetation, converting it into dung, milk and labour energy. Thus while the crop land occupies only about 15% (or 24% of snow-free area) of the total geographical area the agriculture and related activities (collection of firewood, fodder and litter, and grazing) influence nearly 50% of the geographical area or 70% of the entire non-forested area (Tables 7 & 8). Settled agriculture which

makes the nucleus of most human activities entails the expenditure of nearly 10 units of energy from forests and other non-cultivated land for each unit of agronomic production (Singh and Singh 1991). This degree of influence of humans and their domestic animals may vary from one catchment to another, but the nature is similar across the states and watersheds of WHE. The humans and their animals are always present giving no respite to the system to recover. Referred to as chronic disturbance (Singh 1997), this system of degradation is slow and often invisible, but as deleterious as acute disturbance (e.g. cutting of vegetation in one go, frequent use of fire (for promoting succulent new growth of grass).

5 Landcover / Use of Western Himalaya and its states

Vegetation maps for J&K, HP and UA were prepared using remote sensing as a principal input for the landscape analysis. The classified maps have been taken into BioCAP domain for analysis of different landscape parameters.

The large snow cover is a major feature of WH accounting for more than one-third of its geographical area. However, its proportion varies from about 11% in UA to about 46% in J&K. Alpine meadows, forests and managed ecosystems comprising crop fields and orchards are important landuses occupying similar area in WH. The forests of about 63000 km^2 that WH has accounts for about 20% the total forest area of India though it accounts for only 10% of geographical area. If we add about 70,000 km^2 of alpine meadows then the region roughly constitutes one-third of the natural vegetation of the country. The proportion of land under forest is highest in UA and declines westward, while alpine meadows show an opposite trend. However, the forests are highly fragmented in most areas and biomass much lower than the potential. According to one estimate the average forest biomass and net primary productivity are currently nearly half of the potential values. Water bodies though occupy a small area are important component of the landscape. The numerous small lakes along which some of the major hill resorts of India have developed are located mostly in J&K and UA (Tables 7 & 8).

Table 9 Distribution of population, sex ratio, density and decadal growth rate of population : 2001

Inida/State/ Union territory *	Geograpical area (km^2)	Total population			Sex ratio (females per 1,000 males)	Density (per sq.km)	Decadal growth rate
		Persons	Males	Females			
INDIA [1,2]	**3,287,263**	**1,027,015,247**	**531,277,078**	**495,738,169**	**933**	**324**	**21.34**
Jammu & Kashmir [2,3]	204,572	10,069,917	5,300,574	4,769,343	900	99	29.04
Himanchal Pradesh [4]	55,673	6,077,248	3,085,256	2,991,992	970	109	17.53
Uttaranchal	53,485	8,479,562	4,316,401	4,163,161	964	159	19.20
TOTAL WHE	313,730	24,626,727	12,702,231	11,924,496	944.67	122.33	21.92

Notes:

1. The population of India includes the estimated population of entire Kachchh district, Morvi, Maliya-Miyana and Wankaner talukas of Rajkot district, Jodiya taluka of Jamnagar district of Gujarat State and entire Kinnaur district of Himanchal Pradesh whe
2. For working out the density of India and Jammu & Kashmir the entire area and population of those areas of Jammu & Kashmir which are under illegal occupation of Pakistan and China have not been taken into account.
3. While working out the decadal growth of population of Jammu and Kashmir the population figures for 1991 have been worked out by interpolation as 1991 Census could not be held in this State owing to disturbed conditions.
4. Figures shown against Himanchal Pradesh have been arrived at after including the estimated figures of entire Kinnaur district of Himanchal Pradesh where the population enumeration of Census of India 2001 could not be conducted due to natural calamity.

Table 10 Percentage decadal variation in population : 1901-11 to 1991-2001

India/ State/ Union territory *	Decade									
	1901-1911	1911-1921	1921-1931	1931-1941	1941-1951	1951-1961	1961-1971	1971-1981	1981-1991	1991-2001
INDIA [1,2]	**5.75**	**-0.31**	**11.00**	**14.22**	**13.31**	**21.64**	**24.80**	**24.66**	**23.86**	**21.34**
Jammu & Kashmir [3]	7.16	5.75	10.14	10.36	10.42	9.44	29.65	29.69	30.34	29.04
Himanchal Pradesh	-1.22	1.65	5.23	11.54	5.42	17.87	23.04	23.71	20.79	17.53
Uttaranchal	8.20	-1.23	8.74	13.63	12.67	22.57	24.42	27.45	24.23	19.20

Table 11 Sex ratio (female per 1,000 males): 1901-2001

India/ State	Census year										
	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001
INDIA [1,2,3]	**972**	**964**	**955**	**950**	**945**	**946**	**941**	**930**	**934**	**927**	**933**
Jammu & Kashmir [2]	882	876	870	865	869	873	878	878	892	896	900
Himanchal Pradesh [3]	884	889	890	897	890	912	938	958	973	976	970
Uttaranchal	918	907	916	913	907	940	947	940	936	936	964

Note: 1. For working out the sex ratio of India and Jammu and Kashmir for 1991, interpolated figures for Jammu and Kashmir have been used.
3. For working out the sex ratio of India and Himanchal Pradesh for 2001, estimated figures for affected areas of Himanchal Pradesh have been used.

Table 12 Total population, child population in the age group 0-6, literates and literacy rates by sex : 2001

India/ State	Total population			Child population in the age group 0-6			Literates			Literacy rate (%)		
	Persons	Males	Females	Persons	Males	Females	Persons	Males	Females	Persons	Males	Females
INDIA	**1,027,015,247**	**531,277,078**	**495,738,169**	**157,863,145 (15.3%)**	**81,911,041**	**75,952,104**	**566,714,995**	**339,969,048**	**226,745,947**	**65.38**	**75.85**	**54.16**
Jammu & Kashmir	10,069,917	5,300,574	4,769,343	1,431,182 (14.2%)	738,839	692,343	4,704,252	2,999,353	1,704,899	54.46	65.75	41.82
Himanchal Pradesh	6,077,248	3,085,256	2,991,992	769,424 (12.7%)	405,618	363,806	4,029,097	2,266,103	1,762,994	77.13	86.02	68.08
Uttaranchal	8,479,562	4,316,401	4,163,161	1,319,393 (1.5.5%)	692,272	627,121	5,175,176	3,044,487	2,130,689	72.28	84.01	60.26

6 Protected Areas

In J&K there are 4 National Parks and 15 Wildlife Sanctuaries, covering an area of 14872.22 km^2, which constitutes 7.27% of the geographical area. Dachigam National Park is of special significance because of Project Hangul, which was launched in 1970. Wular Lake, situated in Baramula district, covering an area of 8,900 ha is one of the important wetlands of international importance and has been designated as Ramsar site (Anon, 2000).

The protected area network in HP comprises 2 National Park and 32 Wildlife Sanctuaries, covering total area of 7202.25 km^2. The total protected area constitutes 12.94% of the geographic area of the state. Snow Leopard and Monal are important faunal species abounding the protected area. Lake Renuka, a wetland of national importance, with an area of 670 ha is situated in Sirmaur district. Great Himalayan National Park is of particular ecological significance.

The oldest protected area of the region is Corbett National Park in Uttaranchal that was established way back in pre-independence era in 1936. In Uttaranchal only 6474.5 sq. km. is under PAs accounting for 12.11% of the geographical area (Table 13).

Table 13 A list of protected areas in the Western Himalaya

State	Name of the PA	Year of establishment	Area (km^2)
Jammu & Kashmir	Dachigam NP	1981	141.00
	Hemis NP	1981	4100.00
	Kistwar NP	1981	400.00
	Nandini WLS	1981	13.50
	Overa WLS	1981	32.00
	Ramnagar Rakha WLS	1981	12.75
	Surinsar Mansar WLS	1981	39.13
	Trikuta WLS	1981	31.73
	Baltal-Thajwas WLS	1987	210.50
	Changthang WLS	1987	4000.00
	Gulmarg WlS	1987	180.00
	Hirapora WLS	1987	114.50
	Jasrota WLS	1987	10.04
	Karakoram WLS	1987	5000.00
	Lachipora WLS	1987	93.50
	Limber WLS	1987	43.75
	Overa-Aru WLS	1987	425.00
	City Forest (Salim Ali) NP	1992	9.07
	Hokersar WLS	1992	13.75
Total 19 PAs	**Total area with percentage of geographical area**		**14872.22 (7.3%)**

State	Name of the PA	Year of establishment	Total geographical area (km 2)
Himanchal Pradesh	Kalatop-Khajjiar WLS	1949	61.00
	Kais WLS	1954	14.19
	Kanawar WLS	1954	54.00
	Khokhan WLS	1954	14.05
	Manali WLS	1954	31.80
	Shimla Water Catchment WLS	1958	10.25
	Simbalbara WLS	1958	19.03
	Govind Sagar WLS	1962	100.34
	Kugti WLS	1962	378.86
	Lippa Asrang WLS	1962	30.89
	Naina Devi WLS	1962	123.00
	Talra WLS	1962	26.00
	Renuka WLS	1964	4.02
	Bandli WLS	1974	41.32
	Daranghati WLS	1974	167.00
	Darlaghat WLS	1974	140.00
	Gamgul Siahbenhi WLS	1974	108.85
	Majathal WLS	1974	40.00
	Nargu WLS	1974	278.37
	Sechu Tuan Nala WLS	1974	102.95
	Shikari Devi WLS	1974	72.00
	Shilli WLS	1974	2.13
	Tundah WLS	1975	64.22
	Chail WLS	1976	108.54
	Tirthan WLS	1976	61.12
	Rupi Bhaba WLS	1982	269.00
	Pong Lake WLS	1983	307.29
	Great Himalayan NP	1984	754.40
	Churdhar WLS	1985	56.15
	Pin Valley NP	1987	675.00
	Sangla (Raksham Chitkul) WLS	1989	650.00
	Kibber WLS	1992	1400.50
	Dhauladhar WLS	1994	943.98
	Sainj WLS	1994	90.00
Total 34 PAs	**Total area with percentage of geographical area**		**7202.25 (13%)**
Uttaranchal	Corbett NP	1936	520.82
	Govind Pashu Vihar WLS	1955	481.00
	Kedarnath WLS	1972	957.00
	Nanda Nevi NP	1982	630.00
	Valley of Flowers NP	1982	87.50
	Rajaji NP	1983	820.00
	Askot Musk Deer WLS	1986	593.93
	Sonanadi WLS	1987	301.76
	Binsar WLS	1988	45.59
	Gangotri NP	1989	1552.00
	Govind NP	1990	472.08
	Mussoorie WLS	1993	10.82
Total 12 PAs	**Total area with percentage of geographical area**		**6474.5 (12%)**

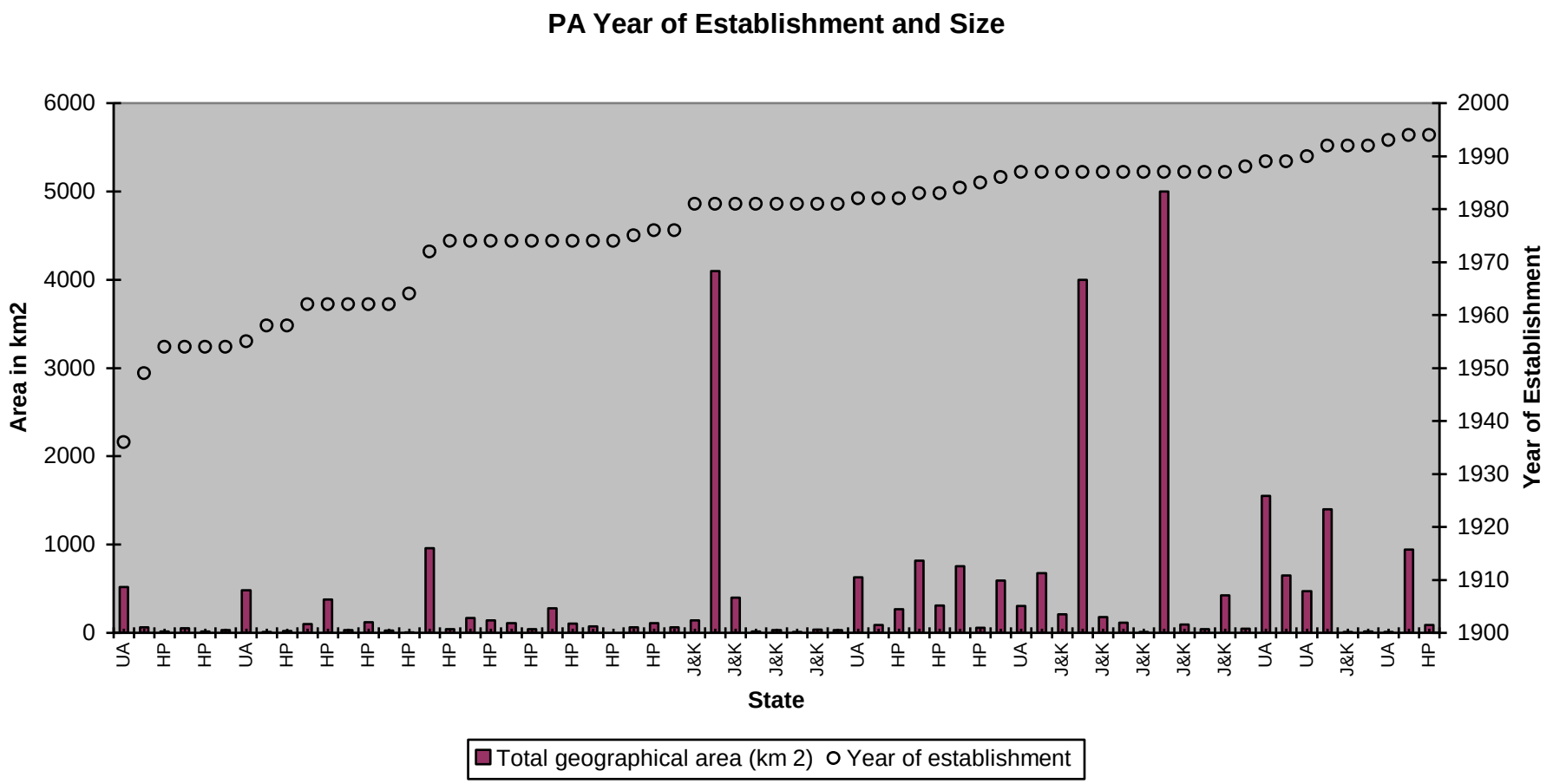


Fig. 3 Size and year of establishment of PAs in states of Western Himalaya

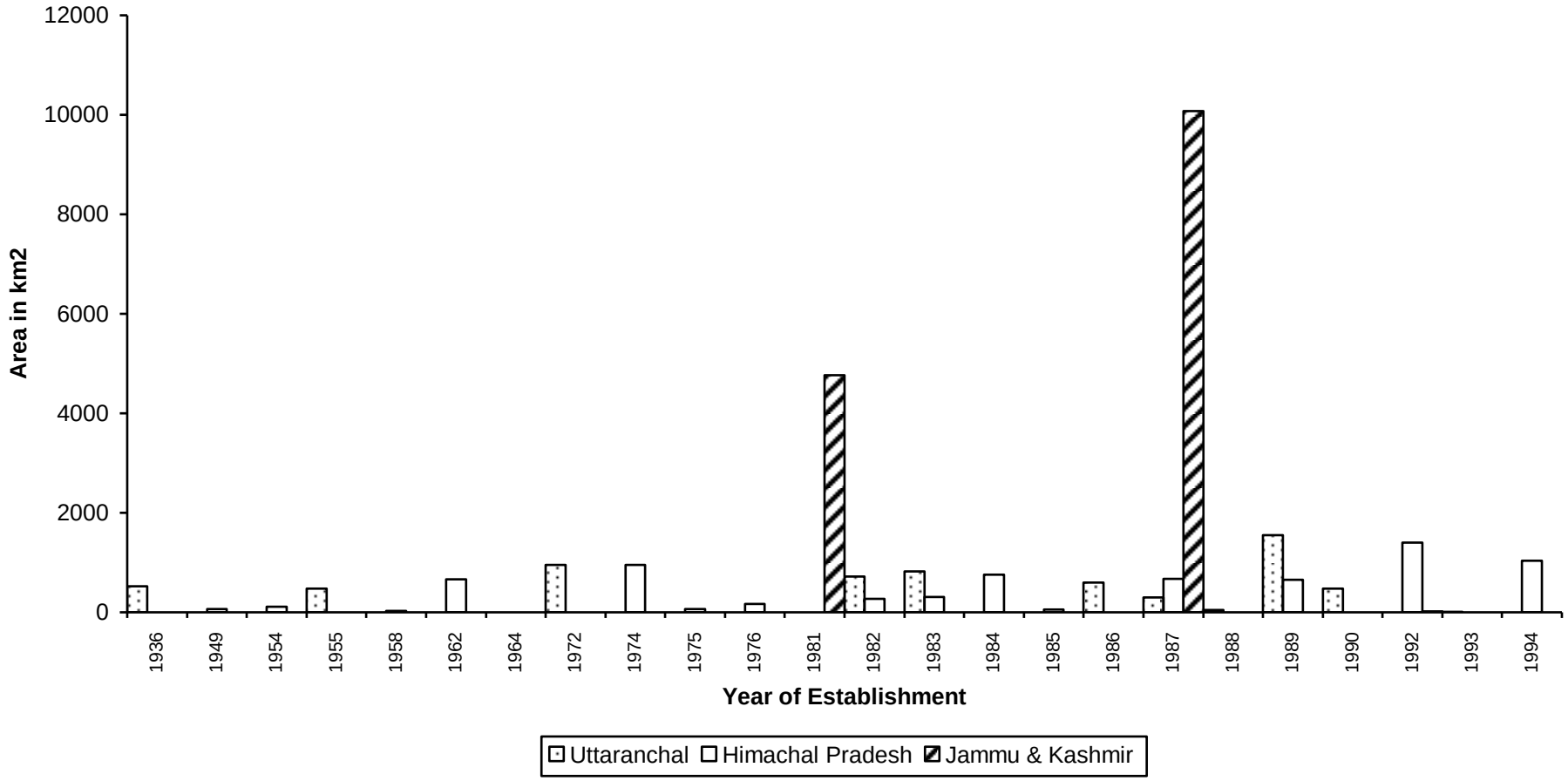


Fig. 4 Year-wise area under PAs in the states of Western Himalaya

7 Joint Forest Management

Uttaranchal leads both in number of JFM committees (7435) and area under JFM (606608 ha) but is second to Himanchal Pradesh (121.72 ha/committee) in terms of area per committee (81.59 ha/committee). Also the average area per committee in WHE (77.84 ha/committee) is about one-third of the national average (226.66 ha/committee). The high national average may be attributed to states like Nagaland and Bihar where the area assigned to the committees is much larger (2727.27 and 1704.74 ha/committee, respectively).

The Government notification for involving local communities in the management of forest resources was issued in 1992 in J&K. At present there are 1,895 village (Rehabilitation of Degraded Forests) Communities which are managing 79,546 ha of forest land (Table 14). JFM is to cover degraded forests and waste Khalsa land. The members are entitled to get a share of 25% of the net proceeds from the first major harvest of the plantation and also to collect grass, fodder, dry and fallen wood etc. free of cost.

Joint Forest Management resolution was issued by the state in 1993 in HP. At present 62,000 ha of forest is being managed by 203 village Forest Development Committees. Only protected forests, which have been degraded in the past, are to be taken up under the JFM programme. The net benefit only is to be shared: 75% to the individual members and 25% to the committee fund.

Table 14 Status of JFM in Western Himalaya

State	**No. of JFM Committees**	**Area under JFM (ha.)**	**Area (ha)/ committee**
Uttranchal	7,435	606,608.00	81.59
Himanchal Pradesh	914	111,247.20	121.72
Jammu & Kashmir	1,895	79,546.00	41.98
Total WHE	**10,244**	**797,401.20**	**77.84**
INDIA	***62,890***	***14,254,845.95***	***226.66***

8 Forest Plantation

Afforestation work in J&K started during the first Five Year plan under 'Forestry and Conservation Schemes'. An area of about 2,700 ha was covered during the first Plan. During the second Five Year Plan, an area of about 8,650 ha was planted (Table 15). The rate of planting increased during 1980s. The total area planted up to 1999 is 0.38 million ha (Anon, 2000).

Table 15 Species wise plantations in J&K by Forest Department upto 1997.

Species	**Area in '000 ha**	**Percentage**
Fruit trees	44.25	37.9
Dalbergia sissoo	4.13	3.5
Juglans regia	17.38	14.9
Acacia arabica	17.15	14.7
Populus ciliata	16.40	14.0
Salix spp.	14.03	12.0
Others	3.49	3.0
Total	**116.83**	**100.0**

Plantation activity started in HP with planting of fast growing and coniferous species during third Fiver Year Plan (Table 16). Soil conservation plantations, mainly of Acacia catechu under river valley Project was also initiated during the period. An integrated watershed development project (Kandi areas) was launched in the state during 1990-91 with the assistance of World Bank. The other important plantation scheme is Indo German Eco-Development Project Changer (GTZ), launched in 1993.

Table 16 Species-wise plantation in H.P. by Forest Department up to 1997

Species	**Area in '000 ha**	**Percentage**
Pinus roxburghii	250.92	32.6
Acaci catechu	139.61	18.2
Cedrus deodara	92.83	12.1
Robinia app.	36.61	4.8
Eucalyptus spp.	31.11	4.0
Picea smithiana /Abies pindrow	15.64	2.0
Poplus spp.	11.32	1.5
Pinus Wallichiana	10.58	1.4
Dalbergia spp.	10.38	1.4
Others	169.53	22.1
Total	**768.53**	**100**

In Uttaranchal plantations never became an important activity, though sal plantations were raised in a few pockets before the Independence. Expansion of chir pine at the expense of broadleaved species, particularly oaks, plantations of deodar particularly oak, plantations of deodar particular oak, plantations of deodar and cypress were raised but never at a large scale. In recent years, however, plantations of eucalyptus, poplar and teak have been promoted both in private and public land in Tarai and Bhabar.

BIOLOGICAL DIVERSITY OF THE WESTERN HIMALAYA ECOREGION: A SKETCH

The Western Himalaya Ecoregion (WHE) is one of the important regions of India's biological diversity. Although this is one of the most studied ecoregions of the country, several components of biological diversity especially information on lower groups of plants, animals and their inter-relationships have not been documented so far. Based on the available records and present day knowledge, a brief sketch on the floral and faunal diversity in the WHE has been given below

(A) Floral Diversity

The Indian Himalaya, stretching from Jammu and Kashmir in the north-west to Arunachal Pradesh in the east includes parts of Trans, Northwest, Western, Central and Eastern Himalaya (Rodgers and Panwar 1988), lies between 27°50'-37°6'N lat. and 72°30'- 97°25' E long. covering approximately an area of 4,19,873 sq. km. with 2500 km length and 240 km width.

Of the total species reported from India, about 20,700 species have been recorded from the Indian Himalayan Region. These species belong to various taxonomic groups *viz.*, Angiosperms (8000 spp.), Gymnosperms (44 spp.), Pteridophytes (900 spp.), Bryophytes (2050 spp.), Lichens (1150 spp.), Fungi (7,000 spp.) and Algae (1700 spp.). About 6,100 species (30%) of the Himalayan flora are endemic. The richness of the flora is due to the occurrence of species of other biogeographic regions like Irano Turanian, Mediterranean, Indo-Chinese, Indian, Malesian, Eastern Asiatic, Circumboreal, Australian, Amazonian, Brazilian, Andrean, North American and others (Samant & Dhar, 1997). As many as 816 species of trees have been recorded from the Indian Himalayan Region. The rich diversity of the Himalaya has been in use by the local communities for various purposes such as medicine, food/edible, fodder, fuel, timber and purposes. The Indian Himalayan Region harbours about 1748 species of medicinal (Samant et al., 1998) and 675 species of wild edible plants (Samant & Dhar, 1997). With the increase in the human

population, the demand of the useful species is also increasing. This has caused rapid decrease in the population of such species. Due to overexploitation and habitat degradation, 145 species of the Indian Himalayan Region including north-east states have been recorded in the Red Data Book of Indian Plants and over 450 species of vascular plants are threatened (Singh, 2000).

Phytogeographically, J&K is most complex. A total of 3,054 species of plants have been recorded from Kashmir Himalaya (Virjee *et al*. 1989), 880 species from Ladakh (Kachroo 1993) and 506 species from Jammu region (Sharma and Kachroo 1981). Families with the largest number of genera are similar between Ladakh and Kashmir but are different for Jammu.

According to Kachroo (1993), endemism in the State among dicots is (about 35%) whereas in monocots it is 18.9%. Endemism is high in families like Berberdaceae, Fumariaceae, Balsaminaceae, Campanulaceae and Primulaceae (Virjee *et al* 1989).

Western Himalaya is richer in endemic legumes than the eastern Himalaya (Rao and Husain 1993) with as many as 35 taxa being endemic to this ecoregion. In addition, this ecoregion is also rich in endemic ferns, containing 19 species as against 14 in Eastern Himalaya (Bir 1993).

According to Dhar (1987), J&K State shows high degree of plant endemism when compared with other areas of the region. More than half of the families are very small with regard to the number of taxa and are thus threatened. Among angiosperms more than 50 families are monogeneric and many of the families are monotypic making them vulnerable to extinction.

The Northwest and western Himalayan provinces support over 4500 species of vascular plants including Pteridophytes, Gymnosperms and Angiosperms. While update and cataloguing of the species is in progress, we present a brief overview of floral diversity as follows:

Rare endangered plants of the WHER

Due to habitat degradation and over exploitation a large number of species have become rare and endangered. These species along with their Red Data Book status (Nayar & Sastry 1989–90) are listed below in Table 17:

Table 17 Rare endangered plants of WHER

Taxa	Endemism	RDB status
Ranunculaceae		
Aconitum deinorrhizum Stapf.	Endemic	Vulnerable
A. falconeri Stapf. var. *latilobum* Stapf.	Endemic	Vulnerable
A. ferox Wall. Ex Seringe	Endemic	Vulnerable
Delphinium uncinatum Hook.f. & Thoms.	Endemic	Vulnerable
Berberidaceae		
Berberis apiculata (Ahrendt) Ahrendt	Endemic	Rare
B. lambertii Parker	Endemic	Vulnerable /endangered
B. osmastonii Dunn.	Endemic	Rare
B. affinis G. Don	Endemic	Rare
Berberis huegeliana Schneid.	Endemic	Indeterminate
B. kashmiriana Ahrendt	Endemic	Rare
Papaveraceae		
Meconopsis latifolia (Prains) Prain	Endemic	Vulnerable
Pittosporaceae		
Pittosporum eriocarpum Royle	Endemic	Indeterminate
Brassicaceae		
Erysimum thomsonii Hook.f.	Endemic	Rare
Caryophyllaceae		
Arenaria curvifolia Majumdar	Endemic	Endangered
Arenaria ferruginea Duthie ex Williams	Endemic	Endangered
Silene kumaonensis Williams	Endemic	Rare
Silene kunawarensis Royle	-	Rare
Aceraceae		
Acer oblongum Wall. ex DC. var. *membranaceum*	Endemic	Rare
Acer caesium Wall.	Endemic	Rare
Apiaceae		
Heracleum jacquemontii Clarke	Endemic	Indeterminate
Rubiaceae		
Clarkella nana (Edgew.) Hook. f.	Endemic	Rare
Rubia himalayensis Klotzsch	-	Rare
R. edgeworthii Hook. f.	-	Vulnerable
Fabaceae		
Hedysarum astragaloides Benth. ex Baker	-	Rare
H. cachemirianum Benth. ex Baker	-	Rare or Vulnerable
H. microcalyx Baker	-	Vulnerable
Valerianaceae		
Nardostachys grandiflora DC.	-	Vulnerable

Asteraceae		
Catamixis baccharoides Thoms.	Endemic	Vulnerable
Chondrilla setulosa Clarke ex Hook. f.	-	R
Lnula racemosa Hook.f.	-	Vulnerable
Lactuca benthamii Clarke	Endemic	Endangered

Taxa	**Endemism**	**RDB status**
L. filicina Duthie ex Stabbins	Endemic	Endangered
L. undulata Ledeb.	-	Endangered
Saussurea bracteata Decne.	-	Rare
S. clarkei Hook. f.	Endemic	Rare
S. costus (Falc) Lipschitz	-	Endangered
Campanulaceae		
Campanula wattiana Nayar et Babu	Endemic	Rare
Cyananthus integra Wall. ex Benth.	Endemic	Rare
Scrophulariaceae		
Picrorhiza kurrooa Royle ex Benth.	-	Vulnerable
Orchidaceae		
Aphyllorchis gollani Duthie	Endemic	Endagered or Extinct
A. parviflora King & Pantl	-	Rare
Archeneottia microglottis (Duthie) Chen	Endemic	Rare
Calanthe alpina Hook.f. ex Lindl.	-	Rare
C. mannii Hook.f.	-	Rare
C. pachystalyx Reichb. f. ex Hook. f.	-	Endangered
Cypripedium cordigerum D. Don	-	Rare
C. elegans Reichb.f.	-	Rare
C. himalaicum Rolfe	-	Rare
Cymbidium hookerianum Reichb. f.	-	Vulnerable
Diplomeris hirsuta (Lindl.) Lindl.	-	Vulnerable
Eria occidentalis Seid.	Endemic	Rare
Eulophia mackinonii Duthie	-	Rare
Flickingeria hesperis Seidenf.	Endemic	Endangered
Neottia inayatii (Duthie) Beauv.	-	Rare
Liliaceae		
Dipcadi reidii Deb et Dasgupta	-	Endangered
Erimurus himalaicus Baker	Endemic	Rare
Lloydia himalensis Royle	-	Rare
Dioscoreaceae		
Dioscorea deltoidea Wall. ex Kunth.	-	Vulnerable
Alliaceae		
Allium stracheyi Baker	Endemic	Vulnerable
Arecaeae		
Trachycarpus takil Becc.	Endemic	Rare
Cyperaceae		
Carex munroi Clarke	Endemic	Indeterminate
Microschoenus duthiei Clarke	Endemic	Indeterminate
Poaceae		

Deyeuxia simlensis Bor	-	Extinct
Puccinellia kashmiriana Bor	-	Rare
Selaginaceae		
Selaginella adunca A. Br. ex Hieron	Endemic	Endangered

Taxa	**Endemism**	**RDB status**
Thelypteridaceae		
Christella kumaunica Holtt.	Endemic	Vulnerable
Stegnogramma himalaica (Ching) K. Iwats.	Endemic	Vulnerable
Athyriaceae		
Athyrium duthiei (Bedd.) Bedd.	Endemic	Vulnerable
Lindsaceaceae		
Lindsaea himalaica Kramer	-	Rare

Further assessment of the species for rarity is required so that complete list of such species could be prepared and strategies for the conservation and management developed.

Among the trees *Litsea lanuginosa* (a large leaved, lauraceous species) is reported to occur at only in one place of 4-5 km^2 in the entire Himalaya for last century. A small thicket of *Meizopteris pellita* (*Butea pellita*) occupying only a few hectares still persists. Unfortunately, these features are not even locally appreciated.

Diversity of Orchids

North Western Himalaya of India supports 238 species of orchids belonging to 72 genera and 5 subfamilies. Among the subfamilies, Epidendroideae is species rich (90 spp.), followed by orchidoideae (53 spp.), Vandoideae (50 spp.) and Neottioideae (42 spp.), respectively. Cypripioideae is species poor, represented by only three species. Among the genera, *Habenaria* (17 spp.), *Dendrobium* (15 spp.), *Bulbophyllum* (11 spp.), *Liparis* (10 spp.), *Eulophia, Eria* and *Oberonia* (9 spp., each), *Calanthe, Herminium* and *Cymbidium* (8 spp., each), *Malaxis* and *Nervillea* (7 spp., each), *Goodyera* (6 spp.) and *Neottia, Listera* and *Vanda* (5 spp., each) show the highest richness of the species. The remaining genera are species poor and represent < 5 species. Due to habitat degradation and overexploitation of most of the host species of the orchids, the status of most of the epiphytic orchids and some of the terrestrial orchids has become threatened. About 15 species of orchids have been recorded in the

Red Data Book of Indian Plants (Table 17). Some of the species such as *Neottia microglottis, Nervillea mackinnonii, Herminium kumaonensis, Peristylus duthiei* var. *inayati, P. kumaonensis, Dendrobium normale, Eria occidentalis, Flickingeria hesperis, Ponerorchis renzii, etc.* are restricted to Indian Himalayan Region and are endemic whereas >50 species extend to adjacent States/Countries, hence are near endemic. In view of the potential of orchids in national and international markets, pharmaceutical industries and sensitivity of the orchids, there is an urgent need to:

- Study the population biology of ecologically and economically important orchids
- Identify the host range of epiphytic orchids
- Identify Pressure Use Index (PUI) and Sensitivity Index (SI) of host plants
- Establish Orchid Reserves; encourage *ex situ* conservation (both conventional and *in vitro* methods)
- Involve local communities in the conservation and management of orchids

Diversity of Pteridophytes

The Pteridophytes form important constituents of ground vegetation in shady and moist habitats. The Western Himalaya is known to have as many as 361 species of Pteridophytes including hybrids, belonging to 88 genera and 43 families. Amongst the families Dryopteridaceae (71 spp.), Athyriaceae (49 spp.), Polypodiaceae ((44 spp.), Sinopteridaceae (20 spp.), Thelypteridaceae (23 spp.) and Pteridaceae (12 spp.) are dominant in terms of species richness. Dominant genera include *Dryopteris* (38 spp.), *Asplenium* (37 spp.), *Polystichum* (27 spp.), *Athyrium* (26 spp.), *Lepisorus* (15 spp.), *Cheilanthes* (14 spp.), *Pteris* (12 spp.), *Diplazium* (9 spp.), *Pyrrosia* (7 spp.), *Adiantum* (7 spp.), *Deparia* (7 spp.), *Phymatopteris* (6 spp.), *Conniogramme* (6 spp.) and *Woodsia* (6 spp.). Helminthostachyaceae, Angiopteridaceae, Plagiogyriaceae, Grammitidaceae, Actinipteridaceae, hypolepidaceae, Pteridiaceae, Marsileaceae, Cyatheaceae, Monachosoraceae, Lindsaeaceae, Onocleaceae, Bolbitidaceae, Oleandraceae and Azollaceae are monotypic indicating narrow genetic base of these families in the area.

The fern flora of the Western Himalaya comprises mainly of temperate elements but at lower elevations, some tropical and even subtropical elements also occur. Kashmir is the limit for some European elements while the Kumaun region is the westernmost limit for many tropical elements. Although, several workers have studies the taxonomy, cytology, morphology and anatomy of Pteridophytes in the region, studies on the habitat ecology of these species have not been carried out so far.

Lichens and fruiting fungi

Forests are rich in epiphytic lichens. They are being exploited from many oak forests. Most of the Western Himalayan forests have ectomycorrhizal associations. These have over 100 fruiting fungi of which more than 50% are ectomycorrhizal. Trees of an oak species alone may support nearly 300 other species on their body that include ectomycorrhizae and other fruiting fungi, angiosperm epiphytes, lichens, mosses, gall forming wasps and parasites, acorn eating birds, mammals and insects, and others.

Agribiodiversity

In the WHE as many as 39 crop species are known to be under cultivation (of a total 166 plant species cultivated in the country). These are further divisible into over 150 varieties. In Uttaranchal alone, 119 crop varieties are known to grow. There is also rich diversity at the genetic level throughout the Himalaya. The loss in diversity has been highest in Himanchal Pradesh due to modernization of agriculture. It has been observed that there is a continued pressure on the traditional farmers to adopt the modern agriculture which is the causes the loss of genetic diversity and land races. To provide sound base for sustainable agriculture production and food supply and development of people in the hills of the Himalaya, it is pertinent that a restraint is observed not to destroy the wide agribiodiversity base and the traditional agro-ecosystems are kept intact. Such planning imbibing above spirit will usher a new era to the Himalayan inhabitants. The *ex situ* and *in situ* conservation of this agribiodiversity must be undertaken on priority. This involves more number of

planned explorations and collection expeditions and also promoting activities like on farm conservation (Sharma, 2000).

Several varieties of rice were grown in the valley till recently. Jammu region is more biased in favour of wheat and barley though certain pockets of this region are famous for rice. Ladakh has a compact form of wheat (*Tritium compactum*) resistant to yellow rust. Ladakh also has naked barley adapted to cold and arid conditions. Other forms also exhibit diversity. These are *Allium* species, Amaranth, Legumes and fruits and nuts like *Pyrus, Prunus,* and *Pinus gerardiana*.

The western Himalaya is considered a region of high diversity with as many as over 125 wild relatives of crop plants reported from this region (Arora and Nayar 1984).

Diversity of Medicinal Plants

The Indian Himalayan region is one of the richest areas in wild medicinal plants. A total of 1748 species of medicinal plants have been recorded from the Indian Himalaya Region. These species are distributed within different life forms viz., herbs (628 spp.), shrubs (189 spp.), trees (175 spp.), and pteridophytes (11 spp.). Amongst the families Asteraceae, Fabaceae, Lamiaceae, Rubiaceae, Euphorbiaceae, Ranunculaceae, Rosaceae, Poaceae, Orchidaceae, Polygonaceae and Gentianaceae are represented by large number of medicinal plant species. Important medicinal plant genera include *Polygonum, Euphorbia, Piper, Aconitum, Swertia, Artemisia, Solanum, Berberis, Desmodium, Allium, Saussurea, Grewia, Clerodendrum, Cassia, Crotalaria, Indigofera, Thalictrum, Potentilla, Zizyphus, Prunus, Blumea, Ipomoea, Dioscorea* and *Coelogyne*. Different plant parts such as leaves, roots, flowers, fruits, rhizomes, tubers, inflorescence, aerial parts, or the products such as resin, latex are used for the treatment of various ailments. Over exploitation of medicinal plants at commercial scale is the major cause of concern in the region. The altitudinal distribution and utilization pattern of medicinal plants indicates that maximum diversity exists in the zone <1800 m and gradually decreases with the increasing altitude. Each altitudinal zone has peculiarity in species composition. Some of the species shows wide range of distribution in the area.

Of the total medicinally important species, 309 are native to the Himalayan region and 30 species native to Himalayan region and other neighbouring biogeographic domains. The remaining species are native to various biogeographic regions, such as Africa, Australia, Oriental India, Tropical Asia, Europe, America, China, Malaya, Java, Japan, etc., hence are considered non- natives in the context of the Himalaya. The rich diversity of non- native species in the Indian Himalayan Region suggests their ability to establish in diverse environmental conditions.

Twenty six species of medicinal plants are restricted to Indian Himalayan region and are identified as endemics whereas 165 species extend their distribution to adjacent areas, hence classified as near endemics. Considering whole Himalaya, the near endemics and also endemics and increases the percentage endemism of the species. Some of the endemic medicinal plants of the region are *Aconitum falconeri, Aconitum falconeri var. latilobum, Aconitum ferox, Aconitum leave, Allium stracheyi, Berberis affinis, Berberis kashmiriana, Berberis petiolaris, Berberis pseudumbellata, Codonopsis clematidea, Codonopsis affinis, Angelica glauca, Angelica nubigena, Archangelica himalaica, Pimpinella acuminata, Pleurospermum candollii, Pleurospermum densiflorum, Inula racemosa, Saussurea bracteata,, Rhododendron anthopogon, var. hypanthum, Astragallus aegacanthoides, Smilacina oligophylla, Lavatera kashmiriana, Malaxis mackinnonii, Pittosporum eriocarpum, Delphinium cashmirianum, Lagotis cashmiriana, Iris kashmiriana* and *Lagotis cashmiriana.*

Among the near endemics, species of *Bupleurum, Selinum, Saussurea, Tanacetum, Impatiens, Berberis, Euphorbia, Corydalis, Gentiana, Swertia, Nepeta, Salvia, Pinus, Polygonum,, Rheum, Aconitum., Delphinium, Potentilla, Thalictrum,* etc. are well known.

Of the 17 medicinal plants recorded in the Red Data Book of Indian Plants (Nayar & Sastry, 1987, 1988, 1990, Samant *et al.*, 1998), 15 species are known from the Western Himalayan area (Table 18). There are other species whose populations are fast decreasing due to their multiple uses and also, high demand in pharmaceutical industries. The notable species are*: Dactylorhiza hatagirea, Meconopsis aculeata, Podophyllum hexandrum, Megacarpaea polyandra, Aconitum* spp., *Rheum* spp., *Saussurea* spp.,

Swertia chirayita, Didymocarpus pedicellata, Angelica glauca, Pleurospermum spp., *Ephedra gerardiana, Taxus baccata* subsp. *wallichiana, Mahonia napaulensis, Berberis* spp., *Allium* spp., *Jurinella macrocephala, Corylus jacquemontii, Codonopsis ovata, Butea minor, Gentiana kurrooa, Salvia lanata, Fritillaria roylei, Gymnadenia orchidis, Paris polyphylla,* etc.

Table 18 Rare-Endangered Medicinal Plants of WHER recorded in Red Data Book of Indian Plants

Taxa	**RDB Status**
Aconitium heterophyllum	Vulnerable
Aconitum deinorrhizum	Vulnerable
Aconitum falconeri var. *latilobum*	Vulnerable
Aconitum ferox	Vulnerable
Allium stracheyi	Vulnerable
Angelica nubigena	Indeterminate
Arnebia benthamii	Endangered
Artemisia absinthium	Vulnerable
Artemisia maritima	Endangered
Atropa acuminata	Endangered
Berberis affinis	Vulnerable
Berberis kashmiriana	Rare
Berberis lycium	Vulnerable
Bergenia ligulata	Vulnerable
Codonopsis affinis	Rare
Datura stramonium	Vulnerable
Dioscorea deltoidea	Vulnerable/ Endangered
Ephedra gerardiana	Vulnerable
Equisetum arvense	Vulnerable
Fritillaria roylei	Endangered
Heracleum candicans	Endangered
Inula racemosa	Vulnerable/ Endangered
Lavatera cahmeriana	Endangered
Nardostachys grandiflora	Vulnerable
Physochlaina praelata	Vulnerable
Picrorhiza kurrooa	Vulnerable/endangered
Pittosporum eriocarpum	Indeterminate
Rheum emodi	Vulnerable
Saussurea bracteata	Rare
Saussurea costus	Endangered
Saussurea costus	Endangered
Taxus wallichiana	Endangered
Tribulus terrstris	Vulnerable
Valeriana wallichii	Vulnerable

There is a wide array of medicinal plants in J&K. Kaul (1977) lists 111 medicinal plants in the temperate and cold arid regions of the state. Established practitioners of traditional medicine were once common but have now been replaced by modern systems of medicine. Some threatened medicinal plants found in the state are *Arnebia benthamii, Dioscorea dettoidea Frittllaria roylei, Heracleum candicans, Taxus wallichiana, Podophyllum emodi* and *Saussurea costus* (Table). Several species are under grave threat in the state. These are *Primula clarkei, Allium auriculatum, Carex annulata*. According to Rao and Hussain (1993) some wild legumes like *Atylosia scarabaeoides, Hedysarum astragaloides* are already facing major depletions in the wild.

Alpine areas are also rich in temperate legumes and grasses. Over 100 species of legumes and 160 species of grasses are known from the state. Important legumes include *Astrogalus, Caragana, Medicago, Melilotus*, and *Trifolium* whereas important grass species are *Agrostris, Bromus, Phleum* and *Chrysopogon*.

Diversity of Wild Edible Plants

Wild edibles form an important source as a supplement or substitute food in the time of scarcity for hill communities. The land holdings in the region are small and can not afford optimum agricultural inputs. Therefore, they rely on a number of unconventional food plants such as *Vigna vexillata*, (L.) *R. rich* (Sophlong), *Chenopopium* (bathuwa), buckwheat (phapar), amaranths (chaulai), mushrooms (guchhi), etc. Different part/s of wild plants such as roots, tubers, rhizomes, stems, leaves, inflorescence/flowers, fruits/seeds/embryo, thallus, fruiting body, fronds are consumed either raw, roasted, fried, cooked, boiled or in the form of oil, spice, seasoning material, jams, pickles etc. Presently their use is limited to certain communities/areas in spite of their potential in local, national and international markets. There is a great scope for enhancing the acceptability of wild edibles as income generating resource for the hill communities and initiating the potential plant resources for human consumption. These attributes have necessitated the identification of such species to develop effective strategies for their wider consumption (Samant & Dhar, 1997).

Of the total species (675) of wild edibles from Indian Himalaya, 440 species are known from the WHER belonging to 268 genera and 124 families. These species are distributed within different life forms viz, trees (11spp.), shrubs (101 spp.), herbs (212 spp.), ferns (8 spp.), fungi (6 spp.) and lichens (2 spp.). Families Rosaceae, Polygonaceae, Moraceae, Asteraceae, Fabaceae, Euphorbiaceae, Anacardiaceae, Rubiaceae, Apiaceae, Urticaceae, Lamiaceae, Alliaceae, Rutaceae, Poaceae and Berberidaceae are the species rich. Among the genera *Rubus, Polygonum, Ficus, Allium, Dioscorea, Berberis, Prunus, Viburnum, Ribes, Grewia* and *Chenopodium*. Like medicinal plants, maximum diversity of wild edibles is also recorded in the subtropical zone and gradually decreases in temperate, subalpine and alpine zones. Some of the species shows wide range of distribution in the area (Samant & Dhar, 1997, Samant et al., 2001).

Fodder resource diversity

Livestock is an integral part of environment and economy especially in the rural areas of the Himalaya. A large livestock population can not be maintained on the fodder produced on arable land alone. Therefore, to maintain the livestock population in sound health and, also economy, they largely depend on the forest resources (Purohit & Samant, 1995).

In remote areas of WHER Himalaya, livestock is the major source of income generation. The fodder obtained from arable land is not sufficient to maintain the livestock in sound health. Therefore, the inhabitants largely depend upon the forest based fodder resource. The major part (62.2 %) of the fodder is extracted from forests (tree/ shrub leaves and herbaceous ground flora). The remaining fodder (37.8%) is derived from agroforestry trees and shrubs, low altitude grassland, degraded land, high altitude grassland and crop residue (Singh et al., 1988).

About 300 fodder (279 to be exact) species from Western Himalaya belonging to 185 genera are commonly used. Of these, 112 species are trees, 67 species shrubs, 37 species are climbers/lianas and 63 species are forbs and grasses. The species of the *Ficus, Quercus, Acer, Bauhinia, Pyrus* and *Indigofera* are commonly used in the region. Majority of the woody species are lopped for fodder except some spiny shrubs such as

species of *Rosa, Rubus, Pyracantha*, etc. which are usually browsed by sheep and goat, rarely by cattle. The forbs and grasses form the major part of fodder collection during rainy and autumn seasons. Among the woody species (216), 82 species are evergreen, 126 species are deciduous and 8 species are semideciduous. The evergreen nature of species suggests their availability throughout the year. On the contrary, the deciduous nature of species suggests their availability in particular season/s (Samant, 1998).

Along the altitudinal gradient the use pattern of fodder species in all the life forms varies to great extent. Like other group of plants the maximum number of species in all the life forms are used as fodder in subtropical (<1800m) and temperate (1801-2800), zones. With the increase in altitude, the species richness, human and livestock population decreases (Samant, 1998). In subalpine and alpine zones, small human and livestock population is dependent on the plant resources. The alpine meadows are mainly grazed by the sheep and goat. Majority of the woody species are distributed in forest habitat. Few of them are distributed in agroforestry systems. The forbs and grasses are distributed in forests, grasslands, meadows and also in agroforestry systems.

Of the total fodder species, 113 are native to Himalaya and 22 Himalaya and other biogeographical regions, together. The high number of Himalayan natives is the indication of high percentage of endemic species in the area. Four (i.e., *Chimonobambusa jaunsarensis, Strobilanthes atropurpureus, Goldfussia dalhousiana* and *Cobresia duthiei*) are restricted to Indian Himalaya. Hence, considered as endemics. On the other hand, 54 species extend their distribution to adjacent Countries/States and considered as near endemics (Samant, 1998). Similarly, occurrence of non- natives *viz.*, species representing biogeographical regions like Irano-Turanian, Mediterranean, Indo-Chinese, Indian, Malesian, Eastern Asiatic, Circumboreal, Australian, Amazonian, Brazilian, North American and others reflect the richness of the plant diversity (Samant & Dhar, 1997).

In the sub-tropical zone species like *Acacia catechi, Acacia nilutica, Albizia labbeck, Bombax ceiba, Dalbergia sisso, Mangifera indica, Morus alba, Pinus roxburghii* are important species for fodder and timber. Morus plantations are important for the silk industry. In the temperate areas *Aesculins indica, Acer caesium, Cettis australis, Lithocarpus pachyphyllus, Pinus wallichiana, Picea simythiana,*

Cedrus deodara, Grevia oppositifolia, Cupressus torulosa, Salix caprea, Populus nigra, Paratopsis jacquemontiana, are important timber and fuel species. In the high altitude areas of Ladakh, village plantations of species like *Salix elegans, Populus alba, Populus cihata, Juniperus macropoda Hippophae rhammoides* and *Caragana pygmae* are useful plants.

(B) Faunal Diversity

Mammalian Fauna:

The mammalian fauna of WHE also exhibit a combination of elements from the Palaearctic, Mediterranean and Oriental regions. Owing to diverse habitats and eco-climatic conditions a large number of mammals (nearly 33 % of Indian species) are recorded in this region (Prater 1980). It is pointed out that exact distribution range of smaller mammals *viz.*, Soridae (shrews), Pteropidae (bats), etc have not been established so far. The fauna of J&K is a mixture of the peninsular Indian elements together with the Tibetan and Palaearctic regions and hence a brief account of the major groups found here is given separately. The major mammalian species within various eco-climatic zones are discussed below:

(i) *The Shiwalik zone or the sub-Himalaya:*

The Shiwalik zone is home to a large number of mammals. Notable among them are the Asiatic elephant (*Elephas maximus*), spotted deer (*Cervus axis*), barking deer (*Muntiacus muntjac*), hog deer (*Cervus porcinus*), sambar (*Cervus unicolor*), porcupine (*Hystrix indica),* wild pig (*Sus scrofa*), common langur (*Presbytis entellus),* and rhesus macaque (*Macaca mulata).* Unlike the eastern region, this area is characterized by the low diversity of arboreal species such as primates and squirrels. Open grassy slopes and woodlands (common in the western region) have more grazing ungulates such as goral (*Nemorhaedus goral).* Among the carnivores tiger *(Panthera tigris),* leopard *(panthera pardus),* jungle cat *(Felis chaus),* jackal *(Canis aureus),* Himalayan yellow throated martin *(Martes flavigula),* and occasional dholes *(Cuon alpinus)* are notable.

(ii) *Temperate zone:*

The area between the Shiwaliks and the great Himalayan range (ca. 1200 – 3000 m asl) comprises the temperate zone. This zone is quite extensive and varies in width greatly. There are basically two types of forested habitats: (i) Himalayan Dry Temperate, and (ii) Himalayan Moist Temperate Forests. Numerous stages of secondary succession, both natural and man made exist throughout the region.

Among the prominent mammals in the region include Himalayan black bear *(Selenarctos thibetanus)*, wild pig, sambar, barking deer, flying squirrel *(Petaurista petaurista)* and common langur. Endangered hangul *(Cervus elaphus hanglu),* musk deer (*Moschus chrysogaster*), serow *(Capricornis sumatraensis)* and Himalayan tahr (*Hemitragus jemlahicus)* are the mammals of immediate conservation concern in this area.

(iii) *Sub-alpine Forests:*

Himalayan musk deer, serow and brown bear *(Ursus arctos)* are the important animals of forest habitats in this zone. Himalayan tahr, and goral occupy open grassy slopes.

(iv) *Alpine zone:*

The alpine habitats (alpine scrub, alpine pastures, and cold deserts) usually start at timberline or the tree line (i.e. ca 3500m asl) and are characterized by the complete absence of trees and lianas. Some of the widely but sparsely distributed mammals of the alpine region are blue sheep *(Pseudois nayaur)*, red fox *(Vulpes vulpes)*, snow leopard (*Panthera uncia)*, Himalayan tahr, mouse hare *(Ochotona roylei)*, Himalayan palm civet *(Paguma larvata)*, and marmots *(Marmota* spp.,*).* Many species are, however, localized in distribution such as, Tibetan wild ass or kiang *(Equus hemionus kiang)* in eastern Ladakh, Tibetan wolf *(Canis lupus)* in inner drier ranges, and ibex *(Capra ibex sibirica)* in a few pockets of Lahaul & Spiti, and western Ladakh. Among the medium to large bodied mammals ungulates, Ursidae, Felidae and Canidae are important. Of these, ungulates form a major component of

the Himalayan mammalian diversity. In total, 19 ungulate species belonging to four families *viz.*, *Moschidae*, *Cervidae*, *Bovidae* and *Equidae*, inhabit the WHE.

The state of J&K has over 75 species of mammals of which 34 species are regarded as globally threatened (IUCN) (Table 19). Of these some species are restricted in their distribution to this region. The notable amongst these is the Kashmir deer or Hangul (*Cervus elaphus hanglu*), whose main population is confined to the Dachigam National Park. A satellite population is believed to occur in Siahbehi

Table 19 Threatened Mammals of Jammu and Kashmir

S.No.	Scientific Name	Common Name	IUCN Red Data List 1996	Wildlife Protection Act, 1972
1.	*Crocidura pergrisea*	Pale Grey Shrew	Vulnerable	Not Included
2.	*Rhinolophus hipposideros*	Lesser Horse-Shoe Bat	-do-	-do-
3.	*Rhinolophus ferrumequinum*	Greater Horse-Shoe Bat	Indeterminate	-do-
4.	*Nyctalus leisleri*	Leisler's Hairy-armed Bat	-do-	-do-
5.	*Nyctalus montanus*	Common Noctule	-do-	-do-
6.	*Myotis longipes*		-do-	-do-
7.	*Vespertilio murinus*	Theobalt's Bat	-do-	-do-
8.	*Panthera pardus*	Leopard	Not Included	Schedule I
9.	*Uncia uncia*	Snow Leopard	Endangered	-do-
10.	*Lynx lynx isabellina*	Tibetan Lynx	Not Included	-do-
11.	*Felis manul manul*	Pallas's Cat	Data Deficient	-do-
12.	*Felis Manul nigripecta*	Red Manul	Indeterminate	-do-
13.	*Canis lupus chanco*	Tibetan Wolf	Vulnerable	-do-
14.	*Cuon alpinus*	Wild Dog	-do-	Schedule II
15.	*Ursus arctos isabellina*	Himalayan Brown Bar	Not Included	Schedule I
16.	*Selenarctos thibetanus laniger*	Himalayan Black Bear	Vulnerable	Schedule II
17.	*Equus kiang kiang*	Western Kiang	Data Deficient	Schedule I
18.	*Cervus elaphus hanglu*	Hangul or Kashmir Stag	Endangered	-do-
19.	*Muschus crysogaster leucogaster*	Himalayan Musk Deer	Indeterminate	-do-
20.	*Bos grunnien grunniens*	Wild Yak	Vulnerable	-do-
21.	*Capra falconeri falconeri*	Flare-horned Markhor	Endangered	-do-
22.	*Capra falconeri Cashmiriensis*	Pir Panjal Markhor	Data Deficient	-do-
23.	*Capricornis sumatraensis*	Mainland Serow	Vulnerable	-do-
24.	*Capra ibex sibirica*	Himalayan Ibex	Indeterminate	-do
25.	*Hemitragus jemlahicus*	Himalayan Tahr	Vulnerable	-do-
26.	*Nemorheadus goral*	Himalayan Goral	Indeterminate	Schedule III
27.	*Ovis ammon hodgsoni*	Tibetan Argali	Vulnerable	Schedule I
28.	*Ovis vignei*	Urial	Endangered	-do-
29.	*Pantholops hodgsoni hodgsoni*	Tibetan Antelope	Vulnerable	-do-
30.	*Pseudois nayaur nayaur*	Himalayan Blue Sheep	Indeterminate	-do-
31.	*Procapra picitícaudata*	Tibetan Gazelle	-do-	-do-
32.	*Eupetaurus cinereus*	Kashmir Woolly Flying Squirrel	Endangered	Not Included
33.	*Eoglaucomys fimbriatus*	Small Kashmir Flying Squirrel	Indeterminate	-do-
34.	*Alticola roylei*	Royle's Vole	Indeterminate	-do-
35.	*Cricetulus migratorius*	Little Grey Hamster	-do-	-do-
36.	*Ochotona roylei*	Royle's Pika	-do-	-do-

Gamgul sanctuary of Himanchal Pradesh near its boundary with the J&K State. Two sub-species of Markhor i.e. flare-horned Markhor (*Capra falconeri falconeri*) and Pir Panjal Markhor (*Capra falconeri cashmirensis*) and found mainly restricted to the Pirpanjal range and into the Pakistan Occupied Kashmir. The Tibetan Gazelle (*Procapra picticauda*) is also a restricted range species whose numbers have fallen drastically in recent years. Kashmir otter (*Lutra lutra kutab*) is also a restricted range species found here. (see table for the full list of threatened mammals). Some other endemic species of mammals found here include Palla's cat (*Felis manul manul*) Kashmir Leopard (*Panthera pardu millardi*). Some threatened species are those found in the other Western Himalayan state. These include the Himalayan Ibex *Capra ibex*, the Himalayan Tahr (*Hemitragus jemiachus*).

Other restricted range species include the Ladakh Urial (*Ovis vignei vignei*), Tibetan Argali (*Ovis ammon hodgsoni*), Chiru Palla's cat (*Felis manul manul*), and Kashmir Leopard (*Panthera pardus millardi*). Other species of concern found here are the threatened mammalian species of the Himalaya like the Himalayan Ibex (*Capra ibex*), the Himalayan Tahr (*Hemitragus jemlahicus*), Serow (*Capricornis sumatrensis*).

Avifauna:

The Himalayan region is richer in the diversity of avifauna than in other groups of animals. This region is known to have as many as 1063 species of birds (nearly 80 % of the total species reported from India), including ca. 300 species of winter visitors from the Palaearctic region (Ali & Ripley 1983). It is interesting to note that WHE as well as Eastern Himalaya have almost equal number of bird species (640 and 675 species in the Western and Eastern Himalaya respectively). The number of families and species of birds in three states of WHE are given below:

Table 20 Number of families and species of birds in the WHE.

State Species	Families	Approx. no. of Bird
Jammu & Kashmir	49	405
Himanchal Pradesh	51	375
Uttaranchal	58	519
Total WHE		**1063**

Of 640 species reported from WHE, 205 species are endemic to WHE. The number of endemic species in J&K, Himanchal Pradesh and Uttaranchal are 53, 11 and 34, respectively. Among the various groups of Himalayan birds the raptors and pheasants are most spectacular and have drawn the attention of conservationists. The Indian Himalaya is represented by 16 species of pheasants which is 94% of the total species of pheasants found in India (17 species) (Table 21). These species occupy various vegetation types and altitudinal gradients (Ramesh *et al.*, 1999). The following table shows the distribution of pheasant species (8) in the WHE.

Table 21 Ecological distribution of the pheasants found in the Indian Himalaya

Sl. No.	Species	Vegetation types	Altitudinal range (m)	Status[1]
1.	**Western tragopan** *Tragopan melanocepahlus* Gray 1829	Upper temperate conifer and sub-alpine oak forests with dense under growth and bamboo patches	2400-3600 (2000 in winter)	V
2.	**Satyr tragopan** *Tragopan satyra* Linne 1758	Temperate conifer and sub-alpine oak forests with dense under growth and bamboo patches	2590-3800 (2000 in winter)	V
3.	**Koklass pheasant** *Pucrasia macrolopha* Lesson 1829	Temperate broadleaf, conifer and sub-alpine oak forests with dense under growth	2100-3300	S
4.	**Himalayan monal** *Lophophorus impejanus* Latham 1790	Upper temperate conifer forests, sub-alpine oak and alpine scrub and meadows	2400-4500 (2000 in winter)	S
5.	**Red junglefowl** *Gallus gallus* Linne 1758	Moist mixed forest and scrub jungle with dense under growth, habitations	Up to 8000	S
6.	**Kalij pheasant** *Lophura leucomelanos* Latham 1790	Tropical and subtropical and secondary forests with dense under growth, habitations	245-3050	S
7.	**Cheer pheasant** *Catreus wallichi* Hardwicke 1827	Rocky slopes with bushes, long grasses, *nullas* and open oak and pine forest	1500-3050	V
8.	**Indian peafowl** *Pavo cristatus* Linnaeus 1758	Deciduous forests, agricultural lands, habitations	Up to 1800	S

1 –McGowan and Garson (1995) (V = Vulnerable, E = Endangered, S = Safe and ? = Not known * - no recent records from India)

J&K has over 350 species of birds of which 10 are threatened with extinction. None of the above species are endemic to this state although species like the western Tragopan (*Tragopan melanocephalus*) and Cheer (*Catreus wallichii*) are typically west Himalayan representatives and restricted range species (Table 22). The Wetlands of the state attract large numbers of winter migrants (see Wetlands).

There are 29 prioritised areas known for birds in WHE (BNHS 2001) (Table 23). They vary in size from biog national parks to a forest stand in Nainital. Bird-watching is one of the attractions of foreign tourists in Nainital.

Table 22 Threatened birds of Jammu and Kashmir state

Scientific Name	Common Name	IUCN Red Data List, 1996	Wildlife Protection Act, 1972
Anser erythrops	White-fronted Goose	Vulnerable	Schedule I
Oxyura leucocephala	White-tailed Duck	-do-	-do-
Aegypius monachus	European Black Vulture	Indeterminate	-do-
Gyps Indicus	Long-billed Vulture	-do-	-do-
Grus nigricollis	Black-necked Crane	-do-	-do-
Fecidula subrubra	Kashmir Flycatcher	-do-	Not Included
Phylloscopus tytleri	Tytler's Leaf Warbler	Indeterminate	-do-
Bradypterus major major	Long-billed Bush-Warbler	Vulnerable	-do-

Table 23 Prioritised list of important bird areas in Western Himalaya

JAMMU & KASHMIR	**Biome 5, 6, 7, 8, 11**	
Dachigam NP	Srinagar	A1, A2, A3
Kishtawar NP	Doda	A1
Limber Valley WLS	Baramulla	A1
Lolab Valley	Kupwara	A1
Overa WLS	Anantnag	A1, A3
Wular Lake	Baramulla	A1, A3, A4(iii)
Mirgund Jheel & Reserve	Srinagar	A1
Chushul	Leh Ladakh	A1, A3, A4
Hanle Shado-Bug	Leh Ladakh	A1
Tsomoriri Lake	Leh Ladakh	A1
Hemis NP	Ladakh	A1, A3

HIMANCHAL PRADESH	**Biome 5, 6, 7, 8, 11**	
Chail WLS	Kharion	A1, A2, A3
Dalli (south)	Chamba	A1, A2, A3
Daranghati WLS	Shimla	A1
Gamgul Siahbehi WLS	Chamba	A1, A2
Great Himalayan NP	Kullu	A1, A2, A3
Kais WLS	Kullu	A1, A2
Kanawar WLS	Kullu	A1, A3
Kugti WLS	Chamba	A1, A2, A3
Rupi Baba WLS	Kinnaur	A1
Tirthan WLS	Kullu	A1, A2, A3
UTTARANCHAL	**Biome 5, 7, 8, 9, 11, 12**	
Corbet Tiger Reserve NP	Nainital, Garhwal	A1
Govind NP, Kulni & Balcha Forest	Uttarkashi	A1
Kedarnath WLS	Rudraparyag/ Chamoli	A1, A2
Khati Reserve and Wacchum (Nanda Devi Biosphere Reserve)	Chamoli/ Bageshwar	A1
Asan Barage	Dehra Dun	A1, A3
Badraj, Banog and Jharipani Sanctuary	Dehra Dun	A1
Sher-ka-danda	Nainital	A1
Tumeria Barrage (Dam)	Udhamsingh Nagar	A1, A2

Herpetofauna (Reptiles and Amphibians):

The reptiles and amphibians are relatively less studied groups of organisms in the WHE. Owing to their Stenothermic (cold blooded) nature, these groups of organisms are largely confined to sub-tropical and warm temperate regions i.e. below 2000 m. The diversity of both the groups of organism, thus decline drastically above this altitude. It is estimated that there are about 90 species of reptiles belonging to ca. 50 genera and 16 families in the region. Of these, two Crocodilians i.e. magger (*Crocodylus palustris*), and ghariyal (*Gavialis gangeticus*) are confined to Ramganga river that passes through Corbett Tiger Reserve in Uttaranchal. The turtles and tortoises are also restricted primarily to the foot-hills of the eastern part of WHE. Common species are three-keeled turtle (*Melanochelys tricarinata),* Indian pond terrapin (*Melanochelys trijuga),* sail terrapin (*Kachuga kachuga*), and Indian Flap-shell turtle (*Lessemys punctata).* Common saurians (lizards and relatives) include the monitor lizard (*Varanus bengalensis*), geckos (*Crytodactylus* and *Hemidactylus* spp.), agamids (*Agama tuberculata*, *Calotes* and *Japalura* spp.), and over 5 species of

skinks (*Mabuya* spp.). The diversity of snakes also increases towards eastern part of WHE. In Uttaranchal alone, there are 41 species of snakes, which include 10 venomous species. Conservation status of most of the snakes in WHE is unknown. It is believed that king cobra and python have become extremely rare largely due to habitat degradation.

As in case of reptiles, there are no recent surveys on the amphibians of WHE. The available records (Waltner 1974) indicate that there may be a minimum of 20–25 anuran species in the WHE. Ray (1995) has enumerated 19 species of anurans under 7 genera and 4 families from Uttaranchal which include 8 species of *Rana*, 4 species of *Amolops*, three species of *Bufo*, and one species each of *Tomopterna, Microhyla, Uperodon*, and *Polypedates*.

Sixty-eight species of reptiles have so far been recorded form J&K. Most of the reptiles are confined to the warmer sub-tropical parts of Jammu. The Steindachner's banded Gecko (*Crytodactylus stoliczkai*) is endemic to the state. The state also has 14 amphibian species of which *Namorana pleskei* is endemic recorded from only one location in the state.

Pisces:

Hussain (1995) has catalogued a total of 124 species of fishes belonging to 66 genera, 27 families and 8 orders from Uttaranchal and Himanchal Pradesh. A complete inventory of fish fauna for the entire WHE is not available. Most interesting aspect of ichthyofauna in the region is a large number of recent introductions for fishery, malaria control and aesthetics. Some of the Indian species introduced in the area include *Catla catla, Cirrhinus mrigala, C. reba, Labeo bata, L. calbasu, LO. Gonius, L. rohita* and *Aplocheilus panchax*). Common exotic species introduced in the hill streams and lakes of WHE are *Carassius carassius, Cyprinus carpio, Ctenopharyngodon idellus, Hypophthalmichthys moltrix, Salmo gairdnerii gairderii, S. g. irideus, S. trutta fario, Gambusia affinis* and *Osphronemus goramy*). Ecological impacts of these introductions in the area have not been assessed. According to Hussain (1995) Ichthiofauna of Garhwal is more divers compared to that of Kumaon.

This could be primarily due to larger catchments and greater extent of lotic ecosystems.

Forty four species of fish have been described from J&K. Several species of carps were introduced into the waters of the state in the 1950's and have affected the survival of the local species. Trouts also have been introduced into the snowfed streamsof the valley and have attracted many anglers. Several species found in the state are restricted range species like the *Nemachilus ladacensis* and *Nemachilus mormorata.* Another species restricted in its distribution is *Schizothorax niger.*

Invertebrates:

The latest estimates of the number of taxa and range of diversity within all the invertebrate groups in WHE are not available. According to an estimate there are about 85,000 species of invertebrates in India (Alfred *et al*.,1998). WHE, by most conservative estimate, may support up to 20 – 25,000 species. Rao and Mitra (1995) have enumerated the molluscs of Western Himalaya (Uttaranchal). According to these authors this region may support as many as 25 species of land mollusks (of the 37 reported from the country). Of these 6 species are endemic to Uttaranchal. Notable among them are the high altitude slugs, *viz.*, *Macrochlamys vesicla*, *M. glauca*, *Syma splendens* and *Bensonia convexa*.

Mani (1974) has given the detailed zoogeography of Himalayan insects. Estimated number of species in various insect groups within WHE, as per the records of Zoological Survey of India (1995) include 415 species of butterflies (of 1450 species in India), 162 species of Odonata (dragonflies), ca. 35 species of Plecoptera (Stone flies), 49 species of Isoptera (Termites),43 species of Dermaptera, ca. 50 species of Hemiptera (bugs), 30 species Carabidae, and over 200 species of Hymenoptera (superfamilies Vespoidea, Apoidea, Chalcidoidea and Proctotrupoidea. One of the larger insect groups (Hymenoptera: Ichneumonidae) is known to have about 300 species in the WHE (Zonathan, 1995). Ecological role of insects is as diverse as the group itself. Their role in phytophagy (insect herbivory), pollinating agents, recycling of nutrients and indictors of biological diversity cannot be over emphasised.

Annelids, represented by earthworms and leeches contribute a major constituent of soil invertebrates. These organisms enhance soil porosity, nutrient decomposition and soil fertility. Thus they play vital in the food chain and are consumed by wide variety of animals. Earthworms, in general can be categorized into three groups, *viz.,* litter dwellers, top-soil inhabitants and sub-soil dwellers. Julka (1995) has enumerated 42 species of annelids from Western Himalaya (Uttaranchal). In a recent study of annelids in a part of WHE i.e. eco-development zone of Great Himalayan National Park, H.P., Julka (1999) reported 11 species of earth worms of which only 4 were native while 7 species were exotic and recent invaders from Europe.

(C) Wetlands

Western Himalayan region and in particular the Jammu and Kashmir state abounds in water bodies of different sizes and character. Over 1,600 km^2 area is under various water kinds of bodies and is notified as protected under various categories. Whereas all water bodies in the valley are fresh water, and of small to medium size, those in the Ladakh region are large and brackish in character.

Due to their importance in the economy of the state, (attracting tourism, fisheries, cultivation of vegetables etc.), and also for biological reasons, they have been subjects of many a studies.

In addition to being highly productive systems, the wetlands provide very important resources of both plant and animal origin. These resources are useful in the day to day life of the local people.

Plants: The lakes harbour a complete range of plants from algal forms to angiosperms. Common algal forms belong to Bacilloriophyceae, Chlorophyceae, Cyaniphyceae, and Eiglenophyceae,. Submerged plants include *Ceratophyllum demersium, Hydrilla verticillata, Vallisnaria spiralis Potomogeton pactinata*. Other important plants are *Typha angustifolia, Phragmites communis Nelumbo Nelumbo* and *Nehumbo alba*.

Animals: The Wetlands of Jammu and Kashmir provide habitats for a variety of fauna, from Zooplanktons to birds and mammals.

In the valley, wetlands like Hokersar, Hygam and Mirgund attract large congregations of migratory waterfowl like Pintail *Anas acuta*, Gadwall *Anas stopera* Shoveller *Anas clypeata*, Common Teal *Anas crecca* and many other species. The wetlands and lakes of Ladakh attract threatened species like the bar headed goose *Aner indicus* and the black-necked crane *Grus nigricollis* among other species.

The wetlands are also important repositories of fish. Commonly found species of fish in these wetlands are *Cyprinus carpio spicularis, Cyprinus Carpio communis, Schizothorax*.. Of the total catch of over 15000 tons of fish, 60% is caught from Wular lake alone.

Deforestation in Western Himalaya and the adjoining regions – an historical overview

When did forest resources become inadequate in the Western Himalaya is difficult to assess. Perhaps subsistence use of wood became an aggravating factor only after 1940s-1950s. Throughout the last century, the primary agent of deforestation was commercial extraction of timber from forests. A case study of Chamba Valley (H.P.) indicates the primary reason for deforestation was commercial extraction during 1880-1990. Though sedentary agriculture was well established as early as the 10th century AD the Chamba valley had relatively undisturbed forest until the British gained political control over the Western Himalaya in the early 19th century. During that period travellers have described that the deodar forests were inexhaustible and trees over 70 m tall were still standing in the Chamba and nearby areas. This was despite export of timber to Lahore markets had begun before the 19th century. Subsequently, as sal depleted from much of the accessible areas the timber contractors aware of the needs of the colonial government had turned their attention to the forest of the Chamba under the control of kings. This was the period when extraction of deodar also took place from the state of Tehri (in UA, an erstwhile hill division of Uttar Pradesh) and Wilson is credited to have started river transport of timber as early as 1860s. The scale was such that by the end of the 19th century almost all of the deodar had been exhausted. The demand of sleepers for expanding railways network and meeting the demand of the two world wars possibly led to the permanent degradation of deodar and sal in many areas. Subsequent to the exhaustion of deodar the contractors diverted their attention to pines as wood preservation techniques improved. When Chamba integrated into H.P. after Independence the forests were severely depleted yet continued to be logged commercially exceeding maximum sustainable yield. After independence forests had become inadequate to meet the people's demand of subsistence living and the broadleaved forests, particularly oaks, were severely degraded to meet the needs of firewood, fodder and litter (Flint and Richard, 1991).

To conclude, deforestation in WHE occurred primarily due to commercial logging for more than a century until the ban on tree cutting was imposed. During the

last 3-4 decades forest degradation was largely due to lopping of branches, browsing and grazing of animals. In recent years the commercial use of NTFPs particularly of lichens, mosses and medicinal plants (Table 18) has become the major cause of human pressures.

The situation of forest degradation and its environmental consequences needs to be analysed in a larger regional context. In a part of south and southeast Asia consisting of Western Himalaya of India, adjacent North Indian Plans, Northeast India, Bangladesh and Myanmar the changes that occurred during 1880-1990 are shown in Table 24.

Table 24 Changes in the area of major land-use categories from 1880 to 1980 in south and south-east Asia, consisting of Western Himalaya, Eastern Himalaya, Gangetic Plain, Bangladesh and Myanmar (169.55 million ha) (from Flint and Richards 1991)

Landuse	**Area (million ha)**				
	1880	**1920**	**1950**	**1980**	
Net Cultivated area	40.34	42.97	47.77	53.55	+ 33
Forest-woodland	47.30	40.99	36.34	30.00	- 37
Interrupted woods	34.06	31.88	30.70	28.41	- 17
Grass-shrubs	25.67	31.97	33.47	34.89	+ 36
Wetlands	6.75	5.72	4.58	3.40	- 50
Surface water	5.80	5.76	5.64	5.73	Stable
Baren-sparsely vegetated	7.76	7.99	8.00	7.81	Stable
Settled-built-up area	1.81	2.26	3.03	5.29	193

(1) The forest area decreased by 37% and the net cultivated area increased by 33%.

(2) Area occupied by vegetation in the wetland was halved.

(3) Apart from agriculture, built-up area and grass-scrub complexes increased at the cost of both natural terrestrial and aquatic vegetation.

(4) The rate of forest-woodland depletion was 1500-16000 km^2 / decade until 1950 and 2100 km^2 /decade thereafter.

(5) The depletion of carbon stock during 1880-1980 was equivalent to 43% of the 1880 stock.

(6) The rate of carbon release increased with time, the values (t / decade) being 228 from 1880-1620, 250 from 1920-1950, and 321 from 1950-1980.

Incorporate biodiversity and ecosystem services in national accounting

From the foregoing it is apparent that WH is connected with a large region where deforestation has been extensive for over a century. This emphasises that the planners need to protect the forests of WH even if some cost has to be incurred. An arrangement should be made to tax the people of a large area around Himalayan to enable people of the mountains to conserve their forests.

India, for that matter any geographical region, requires a certain "ecological structure" around which consumptive activities in rest of the area could be sustained. Western Himalaya along with Eastern Himalaya, Western Ghats and some parts of Central India constitutes the ecological structure for maintaining biodiversity and ecosystem services. There is a need to repair and restore some parts of these areas so that they could realise their potential in providing these services. How we can achieve that warrants elaborate exercises some of which have been addressed in the SAP of this report.

Statement of problems relating to Biodiversity

Table 25 summarises the pattern of environmental degradation that has occurred over several centuries. Ban on whole tree cutting for commercial purpose has helped stemming deforestation in a traditional sense. However, degradation of forests continues as their stocks are inadequate to sustain the subsistence living and because of poor silvicultural practices. Natural regeneration has been ignored, even undermined. Poaching and collective of non-timber forest products have become uncontrollable. In recent years attempts have been made to address issues of participatory management, but they are weak and casual.

Problems relating to biodiversity have been schematically presented in Table 25. The root cause of all the problems is that BD and ecosystem services have not been given due recognition Perhaps this may apply to the whole country. Evidences in support of this are as following:

1. BD and ecosystem services are still not the components of the state forest departments, the university courses and training institutions. How to extract forest resources "scientifically" and plantation work, are still the major concern.
2. Most of the BD issues have centred around some charismatic animals like tiger and elephant. Even in wildlife training focus is on habitat and food of select animals, how the two are related to plant component are even not referred to,

In Table 25 we have summarised the various factors that are related to anthropogenic pressure.

The root cause of problem at present is that we could not bring about enough economic growth (i) to break the cycle of low-quality domestic animal and low quality tree fodder, and (ii) to reduce the day-to-day dependence on forest resources. A natural ecosystem subject to biomass removal requires some period to recover, but because of the above factors the forests in western Himalaya do not get respite from continuous anthropogenic pressure. Consequently, forests fail to recover in spite of freedom from commercial cutting.

The officials of forest department were not given training in participatory forest management. The Van Panchayats in Uttaranchal, as an example, were kept away from any meaningful assistance in terms of training in silvicultural practices and forest management.

Regeneration that formed the major component of the working plans of forest in the past was ignored and plantation became the major activity of the forest department.

The drudgery to which women are subjected did not draw the attention of the development agencies. Consequently hardships faced due to depletion of forest resources could not get due consideration in planning exercises.

Biodiversity and ecosystem services were never considered important component of the forestry taught at FRI or in Universities. The entire focus was on extracting forest resources on so called sustainable basis. This was partly because non-biologists continued to dominate forest services. The scientific foree is woefully small at the country level. The situation in the Himalayan region is still worse. Environmental sustainability is directly related to the number of persons doing science and technology. Lack of the participation of scientists and technologists has made the condition still worse.

Table 25 A summary of threats to biodiversity, forests and other ecosystems in the Western Himalaya

Threats/causes	Time frame (approximate)	Major Consequences	Current status
Commercial logging, (more destructive during railway expansion, wars, extraction system)	More than a century, until 1986	Overexploitation of sal, deodar, disruption of sal regeneration	No more in practice because of the ban on "green" tree cutting
Firewood, fodder and ground litter collection from forest	Right from beginning, still going on	Lopping of oaks, adverse effect on tree regeneration, soil deterioration and disruption within fragments; women drudgery increased	In practice, shortage of broadleaved species leaf litter being felt; no proper silvicultural practices yet introduced

Threats/causes	Time frame (approximate)	Major Consequences	Current status
Free grazing in forests	Right from the beginning	Damage to tree seedlings and saplings, particularly oaks; regeneration of *Q. semecarpifolia* threatened in many areas	In practice; some change in animal composition, e.g. more goats; reduction in transhumance
Frequent but mild burning	Right from the beginning	Damage to oaks and other broadleaved species, promotion of chir pine and some grasses	In practice; getting more extensive; people's co-operation in fire fighting weakened
Charcoal making	Until 1986	Overexploitation of oaks, forest fragmentation, women drudgery increased	No more in practice, because of ban on "green" tree cutting
Shifting cultivation	Right from the beginning, but replaced by sedentary agriculture long ago	Conversion of primary forests into secondary forests, expansion of fire-resistant species, loss of soil carbon and fertility, fragmentation, spread of weeds	No more a problem
Spread of invasive species	Extensive during last half century e.g. *Lantana camara, Eupatorium, Parthenium*	Loss of biodiversity, failure of tree species to regenerate, and rapid carbon loss due to shallow rooting and carbon deposition	Spread continues; has led to a cool but persistent fire regime
Hunting	Common until 1970s	Populations of almost all large mammals depleted from most areas.	Prohibited
Poaching	Grew particularly during last two decades	All charismatic mammals affected	Poachers getting organised and becoming uncontrollable; partly because of the apathy of people, particularly in matters even remotely connected with the SFDs
Commercial collection of medicinal, and aromatic plants (MAP), lichens, etc.	Much of the activities gave occurred during last two-three decades	Populations of several species threatened	Illegal network getting stronger and uncontrollable; there is a lack of awareness and community involvement

Threats/causes	Time frame (approximate)	Major Consequences	Current status
Fragmentation of habitat	For a century or so	Large wild animals threatened; loss of interior species and domination of edge species, including exotics and light demanding hemi-parasites.	Vegetation becoming highly fragmented
Road construction	A major activity during last 3-4 decades	Fragmentation of habitat, accelerated landslides, increase in illegal activities including poaching, tree cutting and collection of MAP	Technology remains crude
Water pollution, eutrophication, and degradation of aquatic ecosystems	For the last 4-5 decades	Loss of fishes, non-palatable species increased, reduced recreational values and drinking water supply, and health hazards	Very serious problem warranting immediate restoration work in case of lakes
Promotion of high yielding varieties of crops by state, universities and other institutions	Last three decades or so	Depletion of crop diversity, increase in the use if pesticides and chemical fertilisers	Growing; but the "save seeds movement" by village-level organisations in UA is a notable beginning to revive biodiversity
Orchards particularly of apple in HP	For last 3-4 decades	Clear-cutting of trees for plantation and to meet demand of fruit cases, use of pesticides, damage to pollinating insects, improvement in economy	Well established in HP; seen as a model of economic growth for also in the new state of UA; but doubts also being raised
Global warming	Being perceived for a decade or so	Receding glaciers, warmer winters, untimely flowering in apple, etc. are perceived as consequences	Likely to be a major issue in immediate future; no attempt yet made to address this threat.
Eutrophication and pollution of lakes, particularly of Kashmir and Nainital	Last 3-4 decades	Decline in the health of aquatic ecosystems, quality fishes, recreational value of lake and water resources.	Lakes still in degraded stages; major restoration work needed.

A Brief Analysis of Gaps

An assessment of why despite the initiatives of the government in terms of legislation and schemes, biodiversity conservation. Some of the shortcomings are given below:

a) **Gaps in information (research and its dissemination):** An acute lack of information about the biological resources of the State is probably a major hindrance in formulation of strategies and plans. In addition to outdated inventories, there is a total lack of knowledge on the ecosystems and ecosystem function to equip planners and policy makers adequately.

b) **Awareness:** The policy makers and planners are not adequately informed about various aspects of biodiversity conservation. Due to lack of such awareness among the masses, citizens movements for environment and biodiversity conservation are not being initiated.

c) **Village level institutions:** Unlike the other parts of western Himalaya (i.e. Uttaranchal), Jammu and Kashmir have a total lack of village level institutions from where conservation work can be initiated at a grassroots level. The recently held panchayat elections may be used to form such local groups which can decide about management of forest areas close to habitations.

d) **Vision:** A long term vision for the conservation of biological diversity is lacking. Such a lack of vision is the reason for lack of properly trained manpower or lacking of training facilities, under-utilization of whatever trained personnel are there. Unless there is a vision, any strategies formulated to conserve biological diversity will never form a main component of the state policy.

e) **Monitoring system:** A major lacuna in the past has been the absence of a monitoring system to assess the success or failure of projects against prescribed objectives. Such assessments help in suggesting any new initiatives or changes required for effective conservation and also meeting peoples aspirations.

f) **Gaps in policy and legal structure:** It appears that the necessary policy and legal framework exists for biodiversity conservation in the state. The Forest

Conservation Act (amended, 1997) provides sufficient legal protection to the forests. However, there are major lacunae such as the ban on tree cutting does not include seedling, saplings and even young trees or health of eecoystens such as water bodies are not given due importance. Also, the area under protected areas network is inadequate, e.g. the Kashmir valley has only about 3.8% of its area protected whereas the Jammu region has 4.22% area under protection. The habitats of Kashmir valley lack adequate protection in the north western side and also the Pirpanjal area, Hirpora WLS not withstanding. Large tracks of good forests remain unprotected in the Kistawar and Baderwah regions of Jammu province. There is also scope to improve Protected Area coverage in the Udhampur district after proper inventories of such areas are made.

g) **Gaps in Institutional and Human Capacity:** Institutions remain sectoral, and requires an integrated approach which has never become a part of forest management training. There are numerous Institutes in Uttaranchal but their contributions to the region have been negligible. Higher education too has not played any significant role. Agricultural universities have remained mostly 'plains-centred' in UA though in Himachal Pradesh have contributed to the economic development. Agricultural universities have focussed only on agronomic production based on fertilisers and pesticides with no concern for biodiversity. Government agencies neither have any understanding nor done any exercise to relate developmental activities with environmental sustainability. For example, neither is ecotourism being promoted by sensitising the tourists in the area concerned nor is the area being prepared for ecotourism. The governmental institutions are in place to conserve biodiversity and provide research inputs. However, grass root organisations are lacking in the state and thus the mass awareness movement about the movement utility of biodiversity is missing. After a gap of nearly 22 years the Panchayat elections were held in the state of J&K with a heavy turnout. These are village organisations and have the potential to initiate biodiversity conservation and steps should be initiated to involve these.

A profile of Jammu & Kashmir – the state in problem

Introduction

The special status of the state of J&K under the article 370 of the Indian constitution also made it different administratively. Also, the long drawn militancy has had a profound effect on the learning and information generation process with the result, contemporary information about the biological resources of the state is lacking. All this necessitated a more focussed approach on J&K State (but also see earlier sections).

In many ways J&K is India's special state biologically it is India's state of alpine meadows and snow, with pockets of Mediterranean climate and biota. It differs also in sociocultural aspects. In view of these it has been given an additional section.

1. Profile

i) Socio-economic Profile:

The geomorphology of the state of Jammu and Kashmir has had a profound influence on the evolution of its society and subsequently three main logistic groups are found here. The natives of Jammu are both Hindus and Muslim by religion and predominantly speak *dogri* although people of places like Kishtawar and Badarwah, which are included in the Jammu province, speak Kashmiri language. The people of Jammu region are mainly farmers and traders by profession. The valley of Kashmir comprises of pre-dominantly Muslim population with a small proportion of Hindus. The native Hindus, called Pandits are Brahamins by caste. The Kashmiri Muslims have traditionally been farmers, craftsmen, artisans and traders including those of the boatmen community, locally called "*hanjis*". However expansion of education has seen the Muslim community take up other professions like medicine, engineering, teaching and others. The Hindus by comparison were always an educated community and were mainly confined to government jobs and others in fields of medicine, teaching and the like. The valley of Kashmir has always attracted people by virtue of its natural beauty and thus a big segment of people is directly and indirectly, dependent on tourism here.

The people of Ladakh province are pre-dominantly Buddhists and Muslims, mainly of Tibetan origins and are mainly cultivators and farmers. Recently, tourism has received a big boost in Ladakh and many have taken up tourism related services as a means of livelihood.

ii) Political Profile:

The population of the state is 10 million (Census 2001), spread over 1,38,942 km^2 (the rest of the area falls under the "Pakistan occupied Kashmir). The area of the state is divided into 14 districts (six districts each in Jammu and Kashmir provinces and two in the Ladakh province). Kashmir province has the highest population density in the State (251.4 people/km^2) followed by Jammu (134.5 people/km^2). Ladakh whose given area also includes 37,555 km^2 under illegal occupation of China has a very low human population density (1.76 people/km^2).

The three provinces have been governed differently over their historical past. The Jammu region was a group of small fiefdoms until they were united politically into a single unit by the Dogra ruler Gulab Singh in the 19th Century.

The history of Kashmir by comparison is old and is chronicled in Raj Taragini. The State was very much influenced by Buddhism till the 11th century A.D. despite being under Hindu rule till the 6th century AD. In the 14th century, Islam spread in the valley and most of the conversions occurred during this period. Kashmir, which at that time was under the influence of Central Asia was annexed in the late 16th century by Akbar forming it a part of the Mughal empire. Thereafter, Afghans took over the state from the mid eighteenth century till it finally, in 1819, passed under the rule of the Sikh empire under Ranjit Singh.

Ladakh was ruled separately since 10 century AD by a Tibetan dynasty and thus the influence of Buddhism was strong here. Central Asian influence was also prominent in this region with the spread of Islam, especially in the Western part. The supply of Pashm to the valley of Kashmir for making of the famous Pashmina shawls was the main trade in those days.

It was only in 1846 after the first Sikh war that British recognised Gulab Singh as the ruler J&K (including Ladakh) and after paying to the British 75 lakh rupees,

Gulab Singh unified the state for the first time. After independence, the political scene of the state became unstable. However, after 1957, representative governments have administered the state following the Indian Constitution despite setbacks to democratic institution especially after 1989 in the form of militancy.

iii) Biogeographical Profile:

On a broad scale, Rodgers and Panwar (1988) divided the State into three Bio-geographic regions i.e. the Trans Himalaya (Ladakh), the NW Himalaya (Kashmir and Jammu hill regions) and the Punjab Plains (Jammu region).

These bio-geographic regions hold varied vegetation types ranging from dry and moist alpine through temperate, sub-tropical and tropical types. Beside the terrestrial ecosystems, Kashmir has a remarkable number of water bodies ranging from alpine glacial lakes, hill streams, rivers, lakes and wetlands.

2. Aquatic systems

Aquatic ecosystems have played an important role in the socio-culture of the state. The economy of many people is dependent on these systems as they provide livelihoods to boatmen, agriculturists, tourism industry etc. The Aquatic systems in the state are however confined to only approximately 0.8% of the total land mass, yet they have a tremendous impact on the lives of the people, the state also depending mainly on hydel power generation. The main aquatic systems found in the state are:

a) **Low altitude lakes** which are fresh water and high in productivity. These are mainly found in the Jammu region.
b) **Valley Lakes:** The valley abounds in lakes of varying sizes and shapes. These are all fresh water.
c) **Forest Lakes:** Found within the hills, these lakes are small as compared to the valley lakes.
d) **Glacial Lakes:** These are high altitude lakes and are found in and above the alpine areas. Some of the lakes in Ladakh are Brakish in nature.

Pressures/ Threats to Aquatic eco-systems:

Main threats to aquatic ecosystems are:

1. **Encroachments:** This has been the main threat to lacustrine systems of the valley with the tow major lakes i.e. the Wular Lake and the Dal Lake having shrunk to approximately half their size in the last 50 years or so. Encroachments along the Wular Lake are mainly from expansion in arable fields for paddy whereas those within the Dal Lake are for housing and vegetable gardens. The Dal Lake traditionally has also had floating gardens (made from dug up weeds of the lake) along north-western edge of the lake. These have increased in size and extent and the older ones have been reclaimed to build permanent settlements. A direct consequence of encroachment into a lake is the degradation of another lake known as the Aanchar Lake on the north-western part of Srinagar city. A major part of this lake is now a residential colony and the remaining portion is a swamp. This lake, a few years ago used to supply the valley of Kashmir with a major supply of reeds for making mats and also of lotus stems (*Nelumbo* sp.) used as food in Kashmir during winters. This supply has now dried up.
2. **Pollution:** Three main sources of pollution to the waterbodies of the state are identified. These are:
    a. **Solid waste:** non-degradable materials like polythene and plastics which are dumped into the lakes and rivers by the local people.
    b. **Organic pollutants:** Most of the human habitations are settled around the water bodies, i.e. the rivers and the lakes. They as a result become the main channel to carry the organic wastes and night soil from the city and villages. A mushrooming of hotels around the famous Dal Lake also attracted all the night soil produced from these, in absence of a proper drainage (sewage) system. The houseboats also have contributed in no mean measure to the organic pollution of the Dal Lake by transmitting organic effluents directly into the lake.
    c. **Inorganic pollutants:** The chemical fertilisers and pesticides used by agricultural farmers around the Dal and Wular Lake as also around most of the wetlands seep into the water. This has caused a build up of

inorganic pollutants and other heavy metals, detrimental to the life in the lake. Aspects of bio-magnification have not been studied but could be a major cause of worry regarding the valley lakes.

All this has been a cause of Eutrophication, especially of the lakes which are enclosed and have a weak water flow.

3. **Siltation:** Degradation of catchment areas of the lakes and water-bodies have brought down large sediment loads into the river and lake systems causing an appreciable increase in the suspended particulate matter. The water bodies lose transparency which may cause changes in the biota. Heavy particulate matter also causes siltation and subsequent choking of lakes and rivers. The Jhelum River is a case in point where the depth of the river is barely a few inches at certain points.
4. **Increased Resource Extraction:** The water bodies have provided many resources to the people of the state. In addition to the vegetables growth in the lakes, the water bodies also provide large stocks of lotus stem and water chestnut which is had with relish in the valley during winter. The lakes also provide reeds for making mats, In addition to this fish abound in the water systems of the state providing cheap protein. However, over exploitation of these resources, especially fish resources have caused major declines in fish yields.
5. **Unplanned Plantations:** Plantation activities have been taken up by the State Forest Department along the wetland and lake edges.

3. Causes for Biodiversity loss in the state

3.1 Proximate Causes of Biodiversity loss.

Proximate causes of biodiversity loss are many. Some of the main causes are summed up below:

a) **Unregulated grazing by domestic livestock:** Over-grazing by livestock of nomadic Gujjars and Bakerwals who own large heads of buffaloes and goat and

sheep, even in their traditional grazing grounds. Grazing by livestock is also of concern near villages where village cattle often stray into forest areas.

b) **Encroachments:** Encroachments by humans into areas of high biological richness is an undesirable trend which needs to be arrested. Encroachments into the lakes are common and have caused a considerable reduction in the area of the lake.

c) **Pollution of water bodies:** see the foregoing part above.

d) **Introduction of exotics:** Introduction of certain species of fish like mirror carp (*Cyprinus carpio*), mrigal (*Cirrhinus mrigala*) are seen as having caused declines in the populations of native fish species like the *Schizothorax*. Several species of trout introduced into several hill streams have adjusted well and their impacts on local biota are not known. Invasion of invasive alien weeds has also posed a serious threat to local biodiversity of the state.

e) **Antropogenic pressures on forest areas:** Forest areas both protected and unprotected, and grazing lands are under tremendous biotic pressures of timber and firewood extraction/collection. Although traditional rights of locals living around the fringes of such areas are recognised, these are often violated. Certain policies of the forest department have also caused alienation of the locals by the forest department (State Forest Trading Corporation), e.g., not allowing the locals to collect dead timber from Reserved Forests as this is now collected by SFTC and sold to locals in depots.

f) **Destruction and modification of natural habitats:** Altered land use patterns especially in the rural areas of the valley are of some concern. While the natural forests are being cleared, community and privatelands are being extensively planted with commercially viable species e.g. *Populus, Salix* etc. Such changes in species composition have not been assessed so far.

g) **Abnormal conditions:** The prevailing abnormal situation in the State has caused considerable damage to biodiversity. While it has been reported that wildlife may have actually thrived in these abnormal conditions due to less hunting/poaching, habitats have actually suffered. In addition to lack of enforcement and the resultant damages to habitats, some indirect affects also caused severe impacts.

The prime among such was the additional pressures of grazing on alternate sites (already used by others) as a result of restricted movements of migrant graziers to sensitive alpine areas. Therefore grazing in such cases is done either at alternate sites or the lower areas. Such additional pressures have created havoc with pastures and forests alike. A case in point is Dachigam National Park where heavy grazing pressures on the alpine areas has had an adverse impact on the grasslands. The presence of increased security personnel has also resulted in increased demands for fire wood and timber and other wood based products.

h) **Over-exploitation of medicinal plants:** Although some medicinal plants are protected by law in the state of J&K, over-exploitation of medicinal plants by traders has caused a substantial decline in the important and threatened herbs. A total lack of quantitative information on the resources precludes any measures of sustainability.

i) **Lack of co-ordination:** There is lack of coordination between various departments working towards conservation of biological diversity. As a consequence, responsibilities are not clearly defined in certain areas. A case in point is the wildlife (migrant waterfowl) on the Dal lake, which is under the responsibility of the lakes and waterways authority.

j) **Loss of tribal culture:** Certain tribes in the state are loosing their cultural identity and with the loss of their culture, loss of traditional knowledge about medicine and other biodiversity related issues is being lost.

3.2 Root Causes of Biodiversity loss

Whereas causes of biodiversity loss are many, the root causes are few and if these are corrected, the proximate causes can get corrected themselves. Some of the root causes identified were:

a) Lack of information on biological content: There seems to be a total lack of information about the species richness of the state. This vacuum has increased during the period of militancy when very little field research has been carried out. Biological inventories are inadequate and in certain cases past records

have been regarded as unreliable. For instance, certain species of fish recorded in the state by former explorers (mainly pre-independence era) are suspected to have been wrongly identified.

b) Lack of awareness: There seems to be a total lack of awareness regarding conservation issues amongst masses, planners and decision makers. Having been in turmoil for over a decade, biodiversity conservation probably gets very low priority in planning. Although a famous and popular sufi saint of Kashmir had commented long back "*An Poshe' telli yelle' wan poshe*" i.e food security will be ensured only when the survival of forests is secured, there seems to be a rather lack of concern amongst masses about biodiversity conservation.

c) Lack of village level institutions: Until recently, there was a lack of institutions at the village level. With a lack of customary laws, conservation at the grassroots level was never achieved. Panchayat elections have been held in the state after a period of over two decades and strengthening these should occupy high priority.

There is also a general lack of effective Non-governmental Organisations to support the government in its conservation and development plans and also to act as "public watchdogs" on policy and project implementation by government and public sector undertaking.

d) Overlapping administrative authorities in important biological areas: Certain important areas are controlled by more than one organisation. For instance the Dachigam National Park just outside Srinagar is controlled by the State Wildlife (Protection) Department but also has presence of state animal husbandry Department and that of the Fisheries Department. Even where important areas are controlled by only one authority, advice from relevant departments is not sought (i.e. the Wular lake and Dal lake in the valley also attract a significant amount of wildlife and fishes yet ownership of resources and therefore the authority of the resource is not properly demarcated.). Such overlapping and unclear demarcation of authority and responsibility has diluted much conservation effort.

e) **Laxity in implementation of Plans:** There is a general laxity in implementation of conservation related plans in the state.

f) **Lacking enforcement:** The inefficacy of laws seems mainly a result of lack of enforcement than any significant shortcomings.

4. Government Initiatives

Several initiatives have been taken by the government for development and conservation of natural resources. Some of them are:

a) **Legal:** Enactment of certain legal provisions by the state from time to time has enabled laws and rules to be framed by virtue of which the natural resources have been managed. Some of these are:

- The J&K Fisheries Regulation Act of 1903
- The Jammu and Kashmir cattle tresspass Act of 1920
- The Jammu & Kashmir Kuth Act of 1921
- The Jammu & Kashmir Forest Act of 1930
- The Jammu & Kashmir Game Preservation Act of 1942
- The Jammu & Kashmir Kacharai Act of 1954
- The Jammu & Kashmir Preservation of specified Tree Rules of 1969
- The Jammu & Kasmir Wildlife Protection Act of 1978
- The Jammu & Kashmir Order or Joint Forest Management (JFM) Notification of 1992

The J&K Forest Act of 1930 is mainly based on the Indian Forest Act of 1927. However there are some differences in that forests under the J&K Forests Act are classified as "Demarcated" "Undemarcated" and "Village" forests. The government can regulate the forest land under the first two categories. In the case of the village forests, any revenue land may be handed over to a village community and the management of this land may be done in accordance with the rules made under the provision. This Act has further been strengthened by virtue of the J&K Forest (Ammendment) Act of 1997.

In addition to the protection of Forests & Wildlife the Fisheries Act of 1903 provides protection to fish through notification of Sanctuaries, Reserved

waters, Protected waters etc. The plants also have been protected under Preservation of specified trees Act and the Kuth Act.

It is therefore apparent that a legal and administrative framework exits in the state of J&K for the Conservation of Natural Resources.

b) **Joint Forest Management Projects:** Started only recently under a J&K government order on Joint Forest Management Notification in 1992, this project has not been subject to any review and consequently not much is known about its impact.

c) **Social Forestry Projects:** Several plantation schemes were taken up under the social forestry projects and most of these have not performed as expected. There still continues to be a Department of Social Forestry within the J&K Forest Department.

d) **Horticulture:** Through its extension programme, the horticulture department has tried to popularise various varieties of fruits amongst the fruit growers of the state. However such introductions have caused a serious decline in the popularity of local low yield varieties. Monocultures are offered to the farmers who are left with no options but to accept the offered varieties, thus reducing the genetic base of the species grown in the orchards.

e) **Medicinal Plants:** As an incentive to conservation of the practice of traditional medicine (Unaani) in the state, the government health service has reserved certain jobs for traditional medical practitioners in the government health department.

f) **Regional Research Laboratory:** The Regional Research Laboratory of the state is involved in the extraction of plant extracts for medicinal use. They have identified several useful colloids and compounds which can be used in the treatment of several medicines and making of compounds useful in such treatments. However, supply and cultivation of medicinal herbs is a problem and the RRL have not been able to attract the locals to take up cultivation of such herbs in spite of an assured market in the form of RRL itself.

g) **Fisheries:** One of the oldest laws concerning natural resources of the state is the Fisheries Act. a separate Directorate now oversees the fisheries in the state.

Over the years, several species of fish have been introduced into the water systems and lakes of the state. Consumption and popularity of exotic carps increased as a result. The increased demand created thereby warranted intensified extraction. The already existing stock of *Schizothorax* suffered as a result as the exotic carp out-competed the native species, being more fecund and also thriving in all forms of water. However, as a result of over-exploitation, the average fish size is now much depleted and also the total fish catch, which has declined significantly. The yields in the valley have become so low that fish is being imported from the Jammu region into the valley to meet the demand.

In addition, various species of trout were introduced into the hill streams of the state. Their effect on the local flora and fauna is not known.

h) Wood based Industry: The state is known for its wood based industry, notably the furniture and wood carving products, joinery products and cricket bats. Whereas predominantly walnut wood is used for furniture and wood carving, Blue pine and deodar are used for joinery products. The cricket bats are made of willow (*Salix*).

The govt. is encouraging small sector joinery units in the state and as a result many are functioning in addition to a few bigger units manufacturing plywood and joinery items. Wood for these units is procured from the State Forest Trading Corporation depots. Inferior wood like the poplar wood is grown locally and procured directly through a system of contractors and agents. The SFTC also supplies walnut wood for the furniture and carving industry. However, the willow is grown commonly all over the valley and is harvested for fuel, making "dantun" and for making cricket bats. As it is not a protected species, it can be harvested freely. Most cricket bat manufacturers grow their own wood.

i) Fur and Fleece based: Fur trade has been banned in the state and as a result now animal fur trade is not practised. Until recently however, Shahtoosh, obtained from the threatened the Tibetan antelope "Chiru" (*Pantholopus hodgsonii*) was in trade and shawls made from this fiber fetched heavy prices.

However recently, due to a reportedly alarming decline in the number of *Chiru*, a global ban under CITES was effected. By virtue of the article 370 of the Indian Constitution, trade and dealing with Shahtoosh was not banned within the state of J&K until recently. It has now been banned but a formal notification to this effect is pending. However, the ban needs to be looked carefully as it also involves killing a tradition, culture and a skill.

j) **Animal Husbandry:** The State Animal Husbandry Department is improving and introducing new strains of sheep and goat. Merino hybrids selected for high yields of wool have now been introduced to sheep farmers through their extension services. This department is also trying to improve the quality of Pashmina, a high quality wool derived from Pashmina goat.

PART II

STRATEGY AND ACTION PLAN

Introduction

The Western Himalaya is India's region of forests, meadows and snow. It is the premier component of India's ecological structure, providing biodiversity as well as ecosystem services to the country. Its importance as the provider of ecosystem services far exceeds that of other ecoregions because of its unique river connections. Threat to both biodiversity and ecosystem services emanating from the region is great, and measures taken in the past could not yield desirable results because of failure to involve the people. In our strategy and action plan emphasis is on both species diversity as well as ecosystem. We understand that one can no longer regard biodiversity conservation as merely the preservation of a few charismatic mega-fauna. Hence, maintaining the ecosystem function is far more important than maintaining the presence of individual species. Thus it is of little significance if the Himalayan Tahr or Snow Leopard can be saved without saving the habitats that these animals survive on.

Vegetation of the Western Himalayan Ecoregion is highly fragmented with large stretches of natural systems are left only in remote areas because of the presence of humans and their dependence on forests and meadows. Therefore, conserving small fragments is important. While substantial work has been done on reducing the very visible threats to the Western Himalayan Ecoregion (WHE) – be it large scale commercial logging, hunting or mining, the pervasive effect of man constitutes an insidious threat. The lopping of young trees or grazing of regeneration by domestic animals does not leave immediately any dramatic signs, but has the potential to degrade the entire landscape with the passage of time. That is why we have focussed on natural regeneration despite human presence, and on corridors to connect fragments. A small forest fragment may not be the ideal habitat for large mammals, but can be enough to save insects and decomposing organisms. No law or policing

efforts can stop this kind of damage. Any attempts to reverse this kind of degradation should rely on long term efforts at providing alternatives to the local people. Conserving biodiversity is more about people than animals or plants for it is usually people who threaten the existence of this biodiversity.

The region is important also because people, at least in some areas, have retained crop varieties in their field and produce food organically. All these need to be recognised as ecological services. But to achieve substantial gains farmers should be compensated for and women in particular must be given some relief from daily drudgery. Building local capacity and then empowering local communities to take control is perhaps the most appropriate solution. A blueprint approach, or one administered by a large centralised bureaucracy will not work. While substantial legislation exists to deter the state or large corporations from indulging in the destruction of natural resources, maintaining the regulatory and watchdog bodies is still very important.

Biodiversity must be linked with local livelihood strategies. Be it the quest for fuel wood for cooking and heating, leaf fodder for cattle, or the open grazing of domestic animals, all these are responsible for significant forest degradation and biodiversity loss in the WHER. Unless due importance is paid to finding alternatives for these biomass products, preserving ecosystems will be difficult.

If the Government must subsidise society, then it is preferable that subsidies be given for efforts that are sustainable. Hence, rather than promoting heavy agricultural subsidies for the purchase of chemicals that greatly reduce the insect diversity (thereby leading to pollinator problems in orchards) and reduce microflora, subsidies directed at ensuring the sustainability of biodiversity can be given. These might include subsidies for constructing biogas plants, or subsidies for promoting private tree plantations. Similarly proven organic techniques of cultivation can be subsidised. Thus, if the region is contributing to downstream areas (the Indo-Gangetic Plains) by helping maintain favourable water regimes or acting as a sink for atmospheric pollutants, then it is not unreasonable for these regions to support the hills by paying some sort of an ‘environment tax’. There is a need to undertake national environment accounting, appropriately valuing the ecological services

provided by different regions and identifying the regions which are benefited by then and are thus able to sustain economic activities.

The unit of conservation should not be individual species but instead entire ecosystems. Stress should be on the holistic ecosystem and the services provided by the ecosystem rather than individual components. Ecosystems and biodiversity cannot be treated as static entities. Thus policies that preserve old trees but pay scant attention to tree seedling regeneration will have disastrous consequences. Forest policy, and programmes aimed at forest preservation in the hills over the past three decades have undermined the importance of natural forest regeneration.

Organisational restructuring needs to be seriously looked into among agencies entrusted with biodiversity preservation. Management of protected areas needs to be modernised by including all components and perhaps the formation of an interdisciplinary department to manage such areas and the biodiversity within needs to be looked at. Management plans and strategies must be proactive rather than reactive.

The proposed Strategy and Action Plan has considered these points, and tried to focus on linkages among various issues listed.

Notes:

- Agencies to be primarily entrusted with the work have been indicated in the parenthesis.
- The estimates of resources given are only indicative and require further study to arrive at actual needs.

List of Abbreviations Used

ACAP = Annapurna Conservation Area Project
ATI = Appropriate Technology India
BCN = Biodiversity Conservation Network, Washington
BD = Biodiversity
BSF = Border Security Force
CHIRAG = A grassroots NGO based in Kumaun
ES = Ecosystem service
FRI = Forest Research Institute
GBPIHED = G.B. Pant Institute for Himalayan Environment Development
GOI = Government of India
HP = Himanchal Pradesh
ICFRE = Indian Council of Forestry Research and Education, Dehradun
J&K = Jammu and Kashmir
JFM = Joint Forest Management
KMTNC = King Mahendra Trust for Nature Conservation
MAP = Medicinal and Aromatic Plants
MoEF = Ministry of Environment and Forests
NGOs = Non-Governmental Organisation
NTFP = Non-Timber Forest Produce
PA = Protected Area
PWD = Public Works Department
RF = Reserved Forest
SFD = State Forest Department
UA = Uttaranchal
VP = Van Panchayat
WH = Western Himalaya / Western Himalayan
WHE = Western Himalayan Ecoregion

IM = Immediate (1-2 years)
ST = Short-Term (2-5 years)
MT = Mid-Term (5-10 years)
LT = Long-Term (>10 years or a continuing process)

Note: All the steps should be initiated within 2 years time using the existing institutions and establish new ones as and when required. The years given for the term are indicative of the period of completion.

Issue 1: Balancing the approaches of environmental conservation by considering ecosystem services as well as biodiversity and develop necessary mechanism for valuation and payment system to the people, include the cultivation of crop varieties and organic production of crops as ecological services

Keywords: Carbon sequestration, developing payment system, economic valuation, ecosystem variability, WH, the ecosystem service providing region.

Genesis:

Almost nothing has been done in regard to developing a conservation approach that considers ecosystem services in an integrated and meaningful way even at national level. Though the Gangetic Plains owes it origin to geological processes, its fertility is largely due to the flow of ecosystem services from the forests of Western Himalaya (Box 1). There is a need to understand the attributes of different ecosystems of WH, the ecosystem services that are generated from them and their valuation for developing a balanced conservational plan (Boxes 2 & 3).

BOX 1

What are ecosystem services?

Ecosystem services in a strict sense are all the services generated as a result of interaction and exchange between biotic and abiotic components of ecosystems. This also includes ecosystem condition. Within ecosystems the interacting organisms help to mediate flows of energy and materials. These energy and material flows contribute towards many ecological or life support services that benefit human welfare. Here in ecosystem services we include numerous invisible but essential services, viz., soil formation and fertility generation, reduction of soil salinity, decomposition and waste dissipation, productivity, carbon sequestration and balance of gases in atmosphere, stabilisation of climate and mitigation of climatic change, nutrient cycling, check on soil erosion, facilitation, assembly of community and succession (in a way it does ecological healing), water and soil retention, water and air filtration, flood and drought control, regulation of water supply and services such as of recreation, aesthetic and religious values. We have not included, however, various goods such as food, fibre, resin and drugs derived from medical plants. Costanza *et al.* (1997) have estimated the total value of the ecosystems (services *plus* biodiversity) at global scale at US$ 33 billion, nearly 1.8 times of the global GNP.

Problem with the current approach of conservation

One of the serious problems that is affecting conservational plan is the prevailing approach of finding ways to reduce costs and maximise benefits of biodiversity conservation. In this approach the focus is on protecting biodiversity-rich areas, as this yields the protection of highest collective numbers of species from the given amount of money input. This approach emphasises on percentage of the global species that can be saved. For example, by protecting the top 25 hotspots occupying only 1.3% of the land over 40%

of the world's species could be saved. Contrary to this, a balanced approach to conservation emphasises that people of every region depend on the daily flow of ecosystem services for managing their living; therefore, there is a need to value and conserve natural ecosystems of all regions. But it does not mean that biodiversity and ecosystems are separate components of nature.

If details were investigated we are likely to find that both are tightly linked, and decline in species richness can lead to decline in overall levels of ecosystem functioning and resultant services to humans. However, from a pure utilitarian point of view it is convenient to explain to the people how their life depends on ecosystem services. As for biodiversity, it is difficult to explain to the people that they need to conserve all organisms for some of these may yield useful products including drugs in the future.

Developing a payment system for ecosystem services

Identification and recognition of ecosystem services may be required at various scales from local to regional, national and global levels. For this connections between ecosystems (such as forest and lake, and forest and cropland) and natural ecosystems and manmade ecosystems are required to be understood. For example, integrating lake and its watershed would be necessary to develop any restoration plan for a

BOX 2

Ecosystem Service from Western Himalaya

Mountains are regarded as the water towers of the world. The extraordinarily massive Himalayan Mountains have shaped the climate of the Indian subcontinent apart from providing water and soil to the Gangetic plains. Among the contribution of Himalaya are the monsoon pattern of rain, high round the year humidity, mild winters and slow lapse rate of temperature with increasing altitude. These influences are reflected in high biodiversity, forest cover up to considerable altitude, dominance of evergreen forest, rapid soil formation, and agriculture round the year.

The ecosystem services of the Western Himalayan forests to the people in the Gangetic plains are listed as following:

1. Rapid soil formation, particularly in oak forests, thus nursing crop-fields both in hills and plains by providing soil and nutrients.
2. Controlling erosion and flood peaks in plains.
3. Maintaining water flow in rivers which contributes to pollution control and help maintain aquatic diversity and soil water storage.
4. Maintaining native crop diversity through human efforts, thus allowing evolution to take place (global importance).
5. Organically produced food (through human efforts, utilising forest services).
6. Carbon sequestration and climate stabilization (global importance).
7. Stabilisation of climate (regional and global importance).
8. Forest services of local use are:

a. Formation of fertile soil utilised in crop-fields.
b. Retention of water as spring water which is the only water source in most areas.
c. Water filtration that serves to keep the spring and lake water clean.
d. Organically produced food.
e. Restoration of landslide sites through the process of succession in which N_2 fixer woody species like alder (*Alnus nepalensis*) and *Coriaria* (a bush) play important facilitating role. *In fact, succession is a composite ecosystem service package, generating soil, nutrients and control over all destabilising physical forces of nature.*

Much of them are due to oak forests, which are not valued commercially. There is a need to value these services in policy decisions.

degraded lake. The western Himalaya and the adjacent Gangetic plains combine to form one unit of environmental management because of the influence of mountains on the plains through the water courses. Though the Gangetic plains owe its many characteristic features to its geology, its perpetual fertility and climatic equanimity are largely due to the nursing effect of the forests of the Himalaya. A recent study indicates that soil and tree water potentials are clearly higher in the adjacent plains than in the mountain site, though climatic factors indicated opposite conditions. In the Gangetic plains people dig out more than one meter soil for brick making, and then they are able to resume agriculture after a few years. This could be made possible because of the downslope flow of soil and humus generated by the oak and other forests of the Himalaya year after year. The young and the rising Himalayan Mountains are full of energy, ready to get released crushing, fracturing and shattering of rocks into pieces. These decomposing rocks readily yield soil under the influence of biota.

To keep this connection going, and flow of mountain services maintained, it is necessary to enable the mountain people to conserve forests and arrangement for payment made for the opportunity foregone. One pragmatic approach can be to provide fuel gas or hydroelectric supply or some non-conventional energy to the people of western Himalaya on an affordable cost so that pressure on forest is reduce to a level that gives respite to the forest to recover. The conservation of biodiversity and forest carbon sink as protective cover of watersheds would be additional outputs of this payment mechanism. For, when we cut wood, we lose both biodiversity and carbon sink. Both the proposed supply of cooking gas and the existing provision of firewood from the forest are a form of subsidy, but the advantages of the proposed subsidy are likely to more than compensate for the cost of supply of fuel gas/electricity (Fig. 1).

Then the life in mountains requires some level of “modern comfort”. The efficient cooking gas energy of fuel gas may prove to be a great relief in daily drudgery, particularly of the women folk.

Apart from the role of facilitators to forest conservation, the people in mountains provide services (i) **by conserving crop varieties**, such as of rice, rajma (a

bean) and pulses (lentils), and enabling evolution to continue; (ii) **by producing organically grown food crops**. It is possible to create a niche market for such environmentally clean food produce. A mechanism of certification for ecofriendly goods may help hill farmers. NGOs and modern cooperatives can also play useful role in marketing organically produced food, free of pesticides and inorganic fertilizers. Already, some progress has been made in this direction. Application of vermiculture or other forms of biocomposting may be included as a part of the package.

As for saving seeds, agricultural universities and institutes need to interact with the "save the seeds" groups (see the work being carried out by Mr. Vijay Jagadgari and others) and initiate steps for developing a suitable payment mechanism.

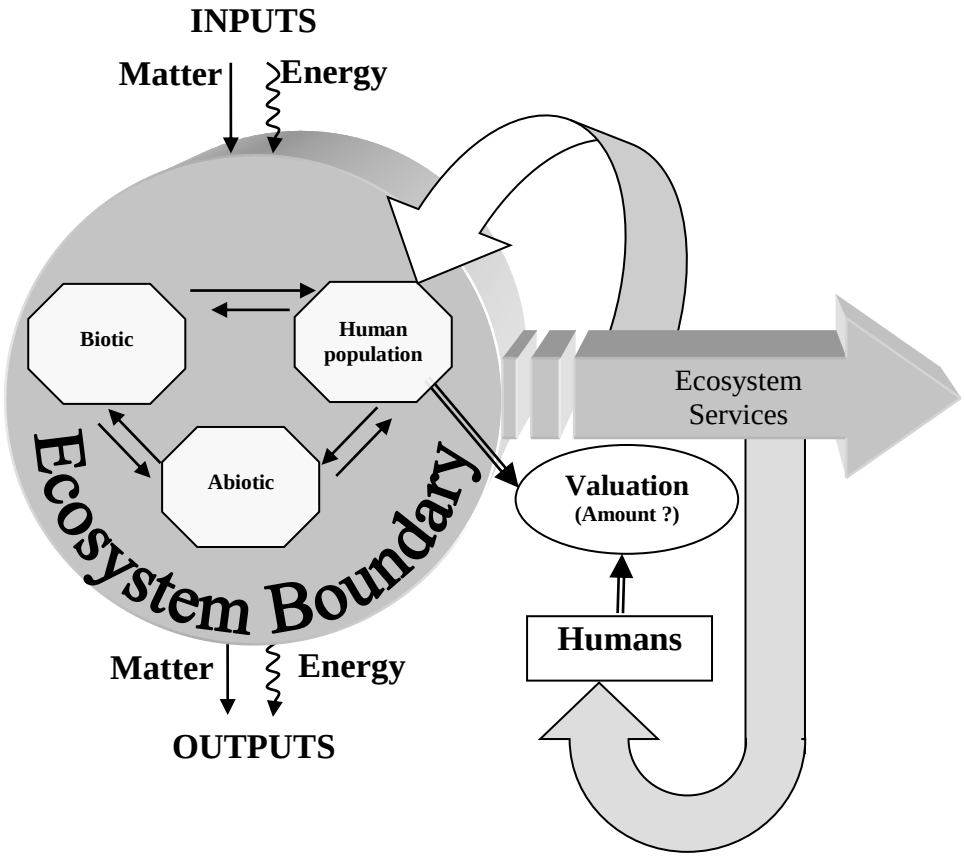


Fig. 1 A representation of connections between the components a circumscribed ecosystem and between ecosystem services and humans. Within ecosystem human population is separated from the biotic component to focus on its extraordinary impact. A circumscribed ecosystem is an open system with inputs and outputs of energy and matter. Outputs such as cleansed water and air are part of ecosystems services. Ecosystems services are always in flow; their use and valuation depends on humans living both inside and outside the ecosystem. Valuation, however, is greatly influenced by human perception, which in turn is influenced by education and institutional context (Singh 2002).

Strategies

1. Integrate ecological, economic and social systems at all spatial scales, and treat the resulting supersystem as the unit of development and management.
2. Identify, monitor and establish at least a first approximation of the magnitude of services in economic terms.
3. Make people aware of their connections with ecosystem services, for on this would depend the people's willingness to pay.
4. Set-up frame for their further analysis, and expand the scope of ecosystem services by considering how ecosystems vary in

BOX 3

Examples of Ecosystem Services

Watershed services

A famous example of ecosystem service is the provision of adequate clean water to New York City by forests in the Catskill Mountains. This was estimated to be equivalent to a capital investment of US$ 6-8 billion and an annual US$ 1-2 billion operating cost for a water treatment plant to carry out the service. The city decided on maintaining water quality via improving forests, imposing control on the use of fertilisers and upgrading local sewerage plants, all combining to cost only US$ 3.5 billion.

A valley-fill (called Sukha Tal or dry lake) catchment of the Himalayan lake Naini Tal provides 40-50% of filtered water to the lake Naini Tal, but zero value has been put on this service. In fact, the valley-fill is being valued negatively and a part of it is being developed into a car parking. The valley-fill serves the society variously: by providing clean water for drinking purpose, by diluting the pollution of lake water, and by keeping the lake water level high, thus increasing its recreational value. There is a need to give special legal backing for protecting such features of watersheds. As far as known to us no attention has been paid to these aspects while undertaking watershed projects in Himalaya, each one involving massive expenditure.

Forest Services

I give below a comparative account of four ecosystems of central Himalaya, out of which three are forests and one dominated by an invasive shrub, *Lantana camara.* The forest ecosystems differ considerably in their ecosystem characters and services they generate. This kind of diversity gives planners opportunity to procure best output for a region keeping in view the human needs and the aspects of sustainability. This kind of exercise needs to be done for all regions, so as to secure a good combination of conservation as well as meeting the people's needs.

Comparison of the ecosystem services of three Himalayan forests

Forest	Ecosystem characters	Ecosystem services
Banj oak (*Quercus leucotrichophora*)	Large biomass (400-500 t ha^{-1}); deep roots and deep carbon storage in soil; high amount of investment of photosynthesis in ectomycorrhizae, massive annual return of nutrients to soil.	Rapid soil formation, high soil fertility, effective carbon sequestration; effective nutrient and water retention.
Chir pine (*Pinus roxburghii*)	Small biomass (200-250 t ha^{-1}); high productivity on degraded slopes, high nutrient use efficiency; high stress tolerance, effective coloniser.	Supply of ecosystem services in inhospitable conditions; retention of nutrients on steep and rocky slopes; moderate nitrogen enrichment (?)
Alder (*Alnus nepalensis*)	Very small biomass (<100-150 t ha^{-1}), very high productivity (up to 30 t ha^{-1} yr^{-1}); rapid coloniser of fresh landslips; very high rate of N-fixation (up to 200 kg N ha^{-1} yr^{-1}).	Facilitation of more useful species, high carbon fixation, nutrient supply to other ecosystems.
Lantana camara (an invasive species)	Very small biomass (<30 t ha^{-1}), productivity similar to oak and pine; carbon shortage in shallow soils, low biodiversity, cool but frequent fires.	Low soil carbon storage, persistent fire regime, low nutrient and water retention.

There is a need to put values to various ecosystem services of each ecosystem, and manage the landscape keeping in view their usefulness, which would vary depending upon the needs of the people. The last example is of an exotic invasive species. Its expansion due to human disturbance leads to a clear-cut loss of services, particularly because of depletion of carbon storage and increased soil and water losses.

regard to services they provide and how to manage them to maximize their combined outputs at various spatial and temporal scales.

5. Incorporate the economic values of ecosystem services into decision making even when they accrue directly to humans without passing through the money economy.

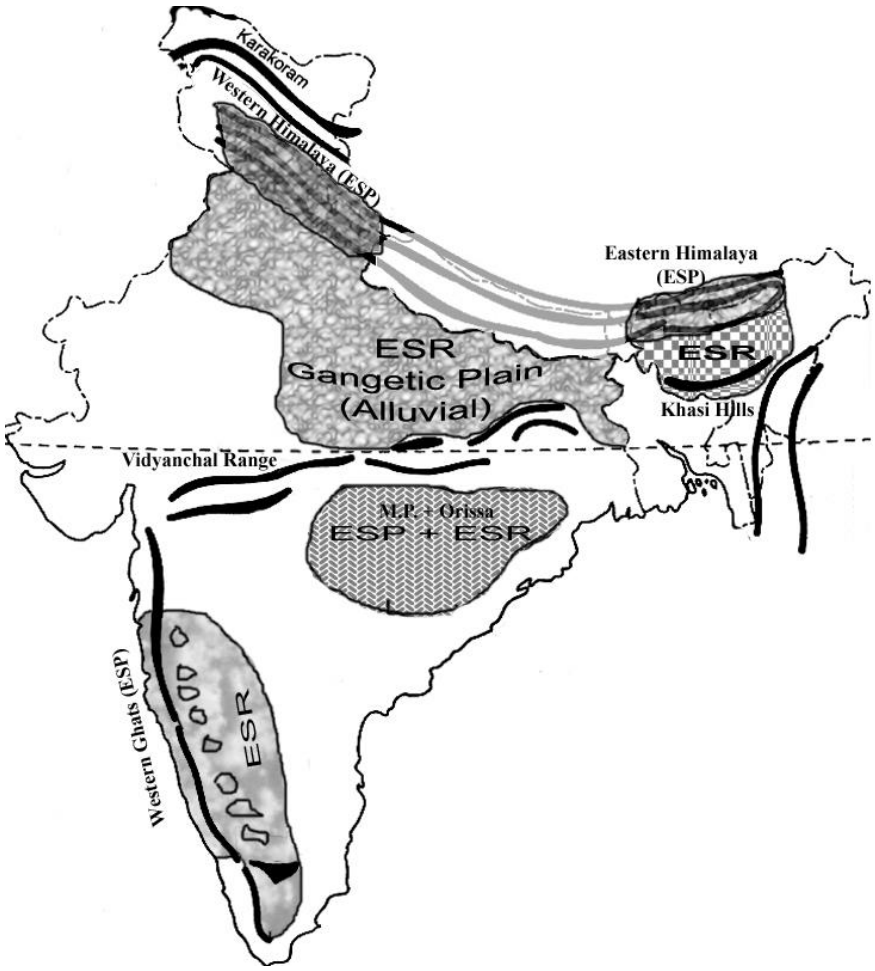


Fig. 1 A representation of principal ecosystem service providing (ESP) regions of India and adjoining service receiving regions (ESR). Areas outlined are approximate. These ESPs are also important in regard to terrestrial biodiversity. Western Ghats and Eastern Himalaya are among the top 22 hotspots. Though not equally important in terms of biodiversity the Western Himalaya exceeds considerably the other regions in terms of ecosystem services, largely because of the large associated territory and river connections.

Actions:

1. Make people aware of (i) the fact that ecosystem services are essential to civilisation; (ii) they operate on such a grand scale and in such intricate and little-explored ways that most of them could not be replaced by technology; and (iii) human activities have already impaired the flow of ecosystem services on a large scale (all concerned institutions particularly schools, colleges and universities).
2. Ecosystems in India are scarcely researched. Undertake detailed studies to understand structure and functioning of ecosystems, linkages among ecosystems and scope of expanding the flow of their services.
3. Undertake additional research to know the entire gamut of ecosystem services at various scales and start with even crudest valuation.
4. Identify and recognise the temporal and spatial scales of the ecosystem service providers (e.g. Western Himalaya) and service user areas, and the people who are associated with conservation or who are facilitators of ecosystem conservation (e.g. people of Western Himalaya) and the people who are getting benefited (e.g. people of Gangetic Plains). Such an exercise is required at all scales: local, regional and global (experts in ecology, economics and social sciences).
5. Create international interest in the ecological importance of WHE in regard to research and management conservation (Scientists, NGOs, Ministry and activists).
6. Modify systems of national and state accounting to better reflect the value of ecosystem services. In many cases economic welfare may indicate decline or levelling in spite of increase in GNP (Financial Institutions, Ecologists, Economists, Planning Commission). It is impossible to do valuation of all ecosystem services at all scales, but there is a need to recognise valuation as an approach or as a process that may help us to bring ecosystem services on to a balance sheet. Valuation of ecosystem services is also required to assess the economic loss that may occur as a consequence of not conserving a given ecosystem.

7. To achieve the above, there is a need to integrate ecology, economics and sociology both at academic and planning level. Provision of imparting training at various levels is a prerequisite. To initiate the process centres need to be developed where mainstream ecologists of the country are able to interact with social scientists. The University Grants Commission and Department of Science and Technology could take the lead in establishing centres for providing training in such an integrated body of knowledge (continuous efforts at all levels).
8. In project appraisals loss in ecosystem services must be weighed against the benefits. This may apply to construction of a big dam or construction of a car parking facility (in the valley fill of Nainital catchment which provides filtered water to Nainital).
9. To enable people of service providing regions (WHE) to conserve forests, provide alternative energy (electricity and cooking gas, etc.) at affordable costs (Planning Commission). The State could be given support for hydroelectricity generation and for providing cooking gas, whichever us feasible at a given place. The objective should be to replace the use of firewood by these energy sources. Since heating is a necessity, electricity for which Western Himalaya has high potential could be found a more convenient and economic energy source.
10. Using knowledge of ecosystem services and people's need, plans can be developed to maximise the combined benefits at a landscape/regional level (experts and developmental agencies).

Resources needed:

1. Research on ecosystem services and valuation and training – ongoing process; allocate fund, about Rs.50 lakhs / yr for next 10 years or so for undertaking research projects, through MoEF, GBPIHED and DST.
2. Payment for supply of cooking energy / developing alternative energy sources like "gobar gar" / energy saving devices. Rs.100 crores per year, to be

continued until economy develops sufficiently to enable people to make payment from their own income.

3. Institute / centres / departments in University to take up teaching, research and training in areas seeking union among ecology, economics and other social sciences. Ecology group of Kumaun University can play a pivotal role. The goal should be to produce trained persons yearly for managing the WHE with the objective of sustaining ecosystem services. Rs.4 crores per year.

Prioritisation has not been done as the steps suggested are interlinked. The need is to apply entire the package.

Issue 2: Crop diversity and organic agriculture to be recognised and promoted

Keywords: Hill agriculture, free-from pesticides, native crop varieties.

Genesis:

Western Himalaya is among the few areas in the world where crop production has still remained organic in many areas, and campaigns are being launched to save seeds of native crop varieties (for example, the "Beej Bachao Andolan" (save seeds movement) of Jardhagaon, Uttaranchal has contributed to saving about 250 rice varieties, 170 rajmah bean varieties, and others. More importantly the movement has originated and spread in villages. Throughout the world problems of pesticides and chemical fertilisers and the spread of monoculture for the production of food are regarded as threat to biodiversity and ecosystem services. The traditional cropping in hills is free from toxic chemicals and can be regarded as a kind of ecological service. The organic agriculture in hills, however, involves gender issues and aspects of sustainability because it is based on forest energy and excessive workload on women.

BOX 1
The Khulgad Watershed Project of Central Himalayan Environment Association (CHEA)

The Project in District Almora, UA is characterised by an integrated approach involving afforestation, organically grown crops, gender issues, providing labour saving tools (such as fodder cutting machines, insect traps and thrashers), water supply, human health and nutrition, capacity building and creation of lasting village level institutions. In this approach CHEA made a detailed guideline in which inter-connections across all components were emphasised. The guidelines were thoroughly discussed with the target community and continuously evolved with their inputs. Once finalised, the programme was undertaken only in those villages where the people agreed in principle to these guidelines.

Institutions were built and improved to tackle the issues of water supply (Pani Panchayat), gender equity (Mahila Mangal Dal - was initiated because women were encouraged to participate in meetings giving them labour saving tools and by enabling them to generate and manage money. In some villages an appeal was made by villagers to establish private forests in addition to community forests so that the labour of women on collecting fodder and firewood is reduced) and health groups. For example, the water supply was connected with fisheries and raising fruit trees for local consumption keeping in view the nutrition problem as well as growing high value crops for marketing (badi elaichi). Cultivation of fruit trees in turn was connected with acceptance of ban on free grazing on the crop field following crop harvest. Each of the village organisations was encouraged to raise funds from their activities to run their organisation. A high percentage of institutions and practices developed about 10-15 years ago continue to function.

Unfortunately, this aspect of hill agriculture has not been given due recognition. Government programmes have helped provide a variety of chemical fertilisers and pesticides, known to be toxic to the environment, at subsidised rates. Already, extensive land areas have been polluted with high levels of pesticides and it will take many years of expensive operation to bring them to organic cultivation

practices again. Currently available organic certification criteria are extremely sensitive even to trace levels of pesticides.

Strategy:

Make organic food production sustainable and treat this along with cultivation of native crop varieties as ecological service and develop market and payment mechanisms.

Actions:

1. Sustainable organic food production: It depends heavily on natural forests (nearly 6 energy units in terms of forest floor litter and fodder are collected for each energy unit of grain yield), and causes heavy workload on women, resulting in their health problem and depriving them from adequate childcare (also see issue on Participatory Management). To make it ecologically sound and socially healthy the following steps may be suggested:

BOX 2
Changing Cropping Patterns

The past years have see some substantial changes in cropping patterns in the Western Himalaya, improved roads and better marketing linkages have allowed many hill farmers to transform, their subsistence yet sustainable cropping patterns into a market driven system. Much higher value off-season vegetables have replaced traditional cereals. This transformation has been largely supported by the administration in the name of agricultural diversification or modernisation. However, little thought is given to the impact of this change.

Vegetable crops usually require much higher input of nutrients than the traditional crops they replace. As chemical fertilizers are not suitable for the sloping rain-fed fields, compost manure continues to be used. However, to generate more compost, a larger amount of leaf litter needs to be gathered from the forest. This leads to depletion of nutrients from forest soils and damage to young regeneration. In addition, larger amounts of dung are required to make the compost and hence more cattle are kept. As a result, the primary function of many hill cattle is to produce cow dung and not the milk. There is little incentive to improve cattle strains. With cattle of poor quality, stall-feeding remains uncommon and cattle are allowed to graze in the forests thereby damaging hardwood regeneration. Also, despite the higher nutrient inputs, the nutrient status of the soil tends to get depleted after many years of these crops.

Unlike the traditional cereals, vegetable crops yields little or no residue that can be used to feed cattle thereby further exacerbating the fodder storage and increasing dependence on the forest. There are also implications for food security by this excessive dependence on the market and price fluctuations that can be quite sharp are added as yet another variable in the farmer's life. Vegetable production also tends to be more influenced by climatic factors and disease than production in traditional crops.

While vegetable crops do help local farmers to increase income, at least in short term, there are several issues of long term sustainability, both of agricultural land and the surrounding forests that need to be carefully looked at before promoting these in the name of agricultural modernisation.

   a. Provide women with simple labour saving tools like thrashers for wheat, cottage scale mills for rice and ropeways for transportation (also see issue on Participatory Management). (**Agencies dealing with rural development, agricultural plans and related**

institutes and NGOs – see efforts made by CHEA in Khulgad Project and by Agriculture Dept. of HP). **[IM]**

b. Grow trees, bushes and grasses next to crop-fields under small private farm forestry (in addition to community forests) to save women's time and energy and to reduce pressure on natural forests. **[IM]**

c. Introduce practices of low-tillage and mulching for cultivation. Low tillage slows down the loss of organic matter and soil moisture, and saves labour energy. While mulching would cut down evaporative water loss and dependence on livestock for manure, and thus reduce workload on women. **[LT]**

2. People of the region are accustomed to buying food, as the agronomic yield caters to needs of 6 months only on an average. By earning more from organically grown crops, the people can buy more food. Further, people of the region suffering from acute poverty can benefit from the money generated by such organically grown crops. This could enable them to cater to their health and nutritional needs better.

   Selling food when people do not have enough food for consumption is often suggested to cause nutritional deficiency and health problems. To address these problems additional health and nutrition awareness programmes would be required rather than depriving people from generating cash. As society learns and matures with respect to health issues, the people would be able to manage themselves better. For example, in Khulgad Watershed Project an integrated approach was followed involving such diverse aspects as water supply, organically grown food, human health and nutrition, fodder plantation both on community and private lands, introduction to fruit trees (from human health viewpoint), marketing viewpoint), marketing agricultural, produce, etc.

3. We could also consider linking crop diversity to the Public Distribution System. The government ration shops may be asked to keep stocks of local varieties of grains. **[LT]**

The marketing of organically produced food could have the following highlights:

a. Safe and healthy food

b. Develop Safe Food Certification system at a regional level **(Agriculture Universities can be entrusted with this task).**

c. Begin with marketing in big cities, both within and outside the country.

d. Create an atmosphere for such safe, healthy, and tasty food through media and extension work.

4. Conserving native crop varieties: **It is a major service initiated in the region, because by cultivating various crop varieties further evolution is ensured.** In contrast, the ex-situ germplasm collection amounts only to the storage of the products of past evolution.

BOX 3

Limitation in developing Orchards

The use of pesticides would continue in orchards and would be in more use as the proportion of orchards increase in size since the development of resistant fruit trees takes longer time than in case of annual crops. The use of pesticides in mountains would mean their spread to a much larger areas than what happens in the plains.

The opportunity foregone in view of the larger interest should be taken into account while developing payment system.

BOX 4

Case Study: Survey of Pesticides Use in Kullu District

This study was undertaken in the villages of Jigala in the Banjar Valley and in Jhiri and Jate of the Kullu valley, District Kullu. The major findings were:

1. With changed traditional land-use patterns there is an increased use of new on-farm technologies in the forms of horticultural tree species and on non-renewable resources.
2. Introduction of chemicals in the forms of insecticides, pesticides and fungicides in the study villages started 20-25 years back; the pace has increased tremendously over the past few years due to spread of apple growing.
3. Some of the banned, dangerous and harmful chemicals are frequently being used by the farmers.
4. Some of the non-recommended synthetic chemicals are being used by the farmers.
5. Availability of desired chemicals at required time to the farmers is lacking.
6. Varieties of chemicals usage has subsequently resulted in a number of short-term and few long-term health impacts on human beings; intensity and frequency of new diseases has increased in the area.
7. Overall ecological, environmental and socio-economic changes have been noted in the study villages.

Suggested corrective measures

1. Number of recommended chemicals in the forms of insecticides, pesticides, and fungicides should be curtailed down to a minimal number based on proper scientific study and the introduction of bio-chemicals.
2. Infrastructural facilities like masks, goggles and body covers should be provided on subsidised price.
3. More technological alternatives are still needed. Knowledge is sorely lacking about sustainable on-farm management.

Source: State of the Environment Report Himachal Pradesh. State Council for Science, Technology and Environment, Shimla, HP

a. **The State** should make payment to the identified, selected and certified farmers (about 3000 in the entire ecoregion) for their biodiversity services, and try to get support from national and international granting agencies. These can be tagged with agricultural universities and institutes. **[MT]**

b. The material can be used as a research resource **(Agricultural bodies like ICAR needs to take initiative)**. **[ST]**

5. Removal of perverse agricultural incentives, such as

subsidies on Green Revolution technologies and inputs; also tackling the fact that there are no financial and other incentives for organic, biodiverse farming.

6. Training and sensitisation of agricultural extension workers towards agrobiodiversity issues, including through workshops with knowledgeable farmers and farmer groups. GBPIHED has done good documentation work on agrobiodiveristy.
7. Reorientation of the R&D at the agricultural research institutes and agricultural universities, such as the G.B. Pant University of Agriculture and Technology and others needs to be done. Already orientation has been initiated. For example, in Uttaranchal, a senior IAS, has initiated several steps including establishment of a network centre of organic manure at Pantnagar University. Vermiculture is being popularised in HP through NGOs.

Resources needed:

To start with 3000 identified farmers would need to be compensated @Rs.2000/ha/yr for their biodiversity services.

Priority:

1. Recognise the maintenance of crop varieties as a service of national and international importance.
2. Improve participation conditions to enable women to actively participate.

Issue 3: Participation remains weak, superficial and ineffective, though participatory management is held out to be the basis of conservation.

Keywords: **Equity, labour saving tools, women participation.**

Genesis:

People have become alienated over the years in regard to forest management. For example, in the past community used to help the state in fire-fighting, but now their contribution is weak and less reliable. In recent years the realisation that forests cannot be protected without people's help has made a place in policy decisions. However, participation still remains weak. It should not be treated simply as an "add-on" to a programme.

Strategy:

Promote participatory management through the strengthening of village level institutions (VLI's), and by expanding its scope and considering all possible interconnections and bringing about necessary social changes. For example, the salient features of the Van Panchayat of Uttaranchal needs to be studied and extended to other states of Western Himalaya. However, participation

BOX 1
Finding Alternates

Collection of biomass from the forest by local villages is today one of the chief causes of forest degradation and biodiversity loss in the Western Himalaya. Chief among these are fuel wood for cooking and heating, and green-leaf fodder for animal feed.

An effective way then to save the forest and the biodiversity they hold is to find alternatives to these products. CHIRAG has been doing this for over a decade and some of the successes are impressive. Biogas was popularized as a means to save fuel wood and also improve the lives of the hill women who spend several hours very day collecting wood. Biogas generation is a chemical process where organic matter such as cattle dung is digested anaerobically by microbes (in the absence of oxygen) to yield a mixture of methane (about 65%) and carbon dioxide (about 35%) Methane (CH_4) is a highly combustible gas and can be used for cooking heating or lighting applications. While, it was initially felt that biogas technology would not work well in the cold mountain environment, CHIRAG has had considerable success working at altitudes as high as 2,000m (6,000 feet). Small sized biogas plants, 1-2 m^3 are built which can be run from dung product off 2-5 cattle - a typical number for families in the region. Biogas allows for a 30-100% saving on fuel wood (depending on the altitude, season, and care taken by the users). In the warm season, fuel wood requirements are typically completely fulfilled by a biogas plant. A survey carried out in December 2001 by CHIRAG found that average fuel wood requirement that had been between 10-30 kg per family before biogas plants were installed, today range from 0-12 kg, a 75% reduction in firewood or a saving to about 15 kg per day. Over the past decade, CHIRAG has built over 1,100 biogas plants resulting in a saving of over 6,000 tonnes of fuel wood annually.

Other programmes that have had an impact in saving biodiversity through a reduction of people's dependence on forest include the popularisation of pressure cooking and a fodder management programmes. As the boiling point of water is low at high altitudes, and hence cooking time is high, the use of pressure cooking (which cuts down on cooking time by raising cooking temperatures) is a particularly effective method of saving energy. CHIRAG also had success in a fodder promotion programmer where people were convinced to stall feed the animals and village forests were closed to cattle. This helped increase the production of natural grass from these protected forest and village with a deficit of fodder started producing a fodder surplus within a three-year period, silage production was also promoted as a way to store fodder for the winter. People no longer had to lop large amounts of green fodder from oak and hardwood trees during the winters thereby protecting these and the forest ecosystem.

Thus, an integrated development approach aimed at improving the quality of life of the local people can have major benefits for biodiversity as well.

should not remain limited to the villages; it should encompass all institutions at various levels. For example, decision making should be the sole prerogative of bureaucratic system, all the relevant people should be encouraged to contribute. How to achieve effective participation of the people should be recognised as a new area of management.

Action plan:

While participatory management is held-out as the basis of conservation, participation remains weak and ineffective. Building local capacity and then empowering local communities to take control is perhaps the most appropriate solution. A blueprint approach to biodiversity conservation where centralised planning is implemented across a multitude of conditions will not work. **Attention must be paid to local conditions** and locally appropriate microplans must be developed.

1. Improve **equity within the community and between communities and outside partners** (e.g. community and forest officials) involved in forest and biodiversity management.
    a. Within-community equity:
        i. Ensure that women and weaker social groups are well represented in the community organisations. Women's issues need to be given special consideration in Uttaranchal and other hill areas where they are over-worked. To achieve this:
            - Take necessary steps to make conditions favourable for women participation (State, NGOs and community). **[ST]:** Provide labour and time-saving tools and promote efficient devices such as "gobar gas", pressure cookers, improved stoves to reduce women's drudgery, as their daily routine of hard physical labour barely allows them to attend community meetings For example, a single small sized (1 cu m) biogas plant, over its lifespan prevents the degradation of over 1 ha of forest. Provide aforementioned tools at affordable cost. (State may initiate). **[ST]**

- Sensitize men so that some of the work of women is shared, and that they (women) feel their participation is important (NGOs and other social groups). **[MT]**
- Adjust meetings timings to suit women (Community). **[IM]**

ii. Contribute to the reduction of collection work by providing access to firewood, fodder, and litter species near homesteads, and by improved manuring (SFD and community managed plantations of these species). **[ST]**

b. Equity between community and the State

i. The state officials should be sensitised to make people their effective partners. The officials need to be considerate to the constraints of people, and respect the knowledge they have. The people should be given training and knowledge to contribute effectively (State). **[ST]**

ii. Ensure **community participation when programmes and projects are conceived and developed**. Developing agencies often seek people's participation after they are ready with the finalised programme (State). **[ST]**

2. Participation should not be reduced to being an "add-on" to a programme. It may be quite time-taking, may involve costs, and warrant new management mechanisms. Effective application of information technology to it may improve participation.

i. Ensure participation of experts, social workers, relevant institutions, etc. when big projects such as of the JFM-scale are undertaken. Often decision makers, first take decisions, then invite experts simply to show that they were consulted (State). **[IM]**

ii. Participation in programmes relating to conservation should be regarded as a kind of necessary duty of the Indian citizens. It amounts to achieving an expanded form of democracy (State). **[IM]**

iii. Therefore, it calls for educating people, participation and training of concerned institutions, universities and colleges, and monitoring changes periodically (State and agencies involved in education). **[IM]**

iv. Given the widespread importance to participatory management, all concerned agencies need to have a participation cell from their resources (State and political institutions). **[IM]**

v. Apart from the State in general, state forest departments, NGOs, forest ecologists, forestry experts, social scientists (with forest as main areas of research) of universities and institutions, and politicians are expected to play significant roles in participatory management of biodiversity. **[ST]**

Resources needed:

Most of the action plan can be undertaken with the help of the present infrastructure after necessary adjustments, change in attitude and restructuring guidelines. Some of the energy saving devices are already subsidised and some need a subsidy, but their popularisation and acceptance among the locals is to be strengthened.

However, financial support would be required for raising plantations next to crop fields and for providing labour saving tools. These can be accomplished through Gram Panchayats, VPs, and NGOs. About Rs.2 crores would be required annually for next five years. See also the issue relating to organic food production.

Priority:

- First, give the highest priority for women participation and creating an environment for it by providing labour saving devices and improving access to fodder and firewood species next to homesteads.
- Second, work out mechanisms for effective participation of experts, social workers and NGOs.

Issue 4: The time-tested and unique institution of Van Panchayat of Uttaranchal needs to be improved and extended to other states of Western Himalaya.

Keywords: Community forest, Joint Forest Management (JFM).

Strategy:

Make the functioning of Uttaranchal's Van Panchayat (VP) more autonomous, self- sufficient and financially viable. It should not be disturbed by creating parallel JFM institution.

Actions:

1. The involvement of the State Forest Department (SFD) in the activities of the VP should be reduced and the government should limit its role to only advisory and supervisory say, as and when required. The SFD should in

BOX 1

A note on: Uttaranchal's Van Panchayat (Forest Council or Forest Committee)

Van Panchayats (forest council or forest committee) were introduced to Kumaun in 1920s following agitation against British expansion of control over forest areas. The landmark Van Panchayat Act 1931 handed over control of designated community forests to elected Van Panchayat (VP) members in place of the State Forest Department (SFD). The VP probably represents one of the largest experiments in common property management in collaboration with the state (both SFD and State Revenue Department). In this an elected body, called forest committee or forest council holds responsibility of using and managing village forest resources. However, the various activities are under the control of rules of the Revenue Department, and the SFD is supposed to provide technical inputs. In a way, the village forest is a resource, used by a definite user group (the village people) and is liable to degradation due to over use. Though called village property, the land in reality belongs to the State; however, village people consider it as a collective property and resent government interferences. It is not a common property of Hardin (1968) with open access and no rules for governing the use of or control over a resource.

Most community forests were initiated on degraded sites, officially on a kind of civil/soyam forest, falling under administration of the Revenue Department. But unlike Civil Soyam forests the community forests are not open-access forests. Depending on the number of households in a village, there are generally 5-9 elected members in a VP, who elect a "*sar panch*" from among themselves. Elections are held after 5 years. At least one scheduled cast and/or woman member should be elected to the committee.

Responsibilities:

The responsibilities are laid out in the law as following: (i) To ensure that only those trees that have been considered silviculturally fit for cutting by the SFD would be cut. (ii) To ensure that the village forest land is not diverted to any other use. (iii) To erect and maintain boundary pillars. (iv) To carry out the directions and execute the orders given to it by the State Revenue Department (SRD) (on the advice of SFD) to maintain, improve and exploit the forests. (v) To utilise the forest produce to the best advantage of village community and of the right holders, recognised by established customs or permitted by the SRD. (vi) To close generally at least one-fifth of the grazing area to promote conservation. (vii) To protect the forest from fire, illicit felling and damage to trees due to lopping.

Functioning:

A watchman is appointed to guard the forest, and his salary (generally only Rs.200-400 per month) is paid by the community. He is authorised to take action against offenders. In some villages, households watch the forest on a rotational basis. The VP may grant permission for cutting grass, grazing and collection of fallen wood, and may charge fees for these provisions with the permission of the Government. The other rights include extraction of pine resin for domestic and medicinal purposes and disposing of trees with the permission of SRD (on advice of SFD). The trespassers can be fined up to Rs.50, and up to Rs.500 with the permission of SRD. If rules for grazing are violated cattle can be detained up to 48 hours, and the VP has the right to disallow the use of privilege of any person found guilty.

Within these limits, each VP makes its own rules and regulations as per needs and wisdom.

Motives for forest management are founded upon expectations of immediate product returns as well as to make sacrifices for forest conservation (e.g. foregoing community forest use). Desire to prevent outsiders from using forest and to become self-sufficient in firewood, leaf litter (for manuring) and fodder is said to be the driving force for the development of community forests in some villages with a high level of success (Britt-Kapoor 1995). contd…

fact concentrate on providing adequate knowledge about appropriate silvicultural practices, particularly relating to vegetation (SFD). **[ST]**

2. The process of budget making and utilisation should not only be made less bureaucratic, but also more transparent and participatory. Instead of strengthening the control of SFD, the community should be made more capable to handle finances. There should be a provision for getting approval of the village by involving representatives from all households. To achieve this, a kind of **General House of the Van Panchayat** can be instituted that would include representative of each household. They can meet once or twice a year for the purpose. (SFD and VP) **[ST]**

3. There are many success stories in VPs in which degraded/ deforested land was restored and made a VP forest. This shows that such a kind of participatory institution can be used to recover deforested land under even reserved forests category. In brief all the deforested land which the SFD has been unable to reforest in over a decade time or so should be handed over to the VPs. This would lead to an adequate size of VP making sustainable forest use feasible. Once the adequate size of

Continued…
A note on: Uttaranchal's VP

Role of NGOs

NGOs in certain cases have made useful contributions. For example, CHIRAG, while working in Kilmora and Katural VPs Nainital districts redefined the forest guard as "forest maintainer", and he was also trained to improve the growth condition of tree seedlings and saplings, repair boundary walls and protect trees from excessive lopping.

Gender Issues

Though at least one woman is required to be in the VP, her forced inclusion has not led to genuine representation at least in above VPs of Nainital district. The female representatives either send their son or husband, they are reluctant to attend the VP meetings. The most obvious constraint is the heavy workload involving bulk of childcare, collection of fuel wood, fodder, litter and water, cooking, other household and agricultural activities. Also they feel that they are not encouraged by men to attend meetings. In recent years this issue has been raised repeatedly and men in some cases seem to welcome women participation, but not much progress has yet been made.

Success and failure

At present there are about 5000 VPs in Uttaranchal occupying nearly one-fourth of the forest area. Typically, the VPs become dysfunctional where village forest area is inadequate to meet the community needs (at least 1 ha of forest is required per household), where villages are very small (less than 30 households) or very large (over 100 households), where out-migration is high, where government officials are insensitive, and where members are busy along with other occupations like maintaining shops and jobs in nearby areas. The fact that in many areas VPs have been successful in conserving forests clearly indicates their importance.

Apart from this, village forest in way represents (i) a kind of empowerment to the people, and (ii) people's participatory role in the functioning of the nation. It represents important social institution in which more creative activities can be initiated.

Present scenario

There is a fear that the JFM scheme funded by the World Bank may disrupt the VP functioning that had been working without any outside financial assistance. The funding would stop once the scheme tenure is completed and it might be difficult to revive old the culture once the people get used to the outside support. The recent Forest Van Panchayat Niyamawali, though an improvement in certain aspects has still not freed the VPs from the irksome bureaucratic practices.

VP forest is achieved, forest use of the people in the reserved forest can be stopped. This would enable in fixing clear-cut responsibilities of the Govt. in the case of RFs and the people for VP forests (SFD). **[LT]**

4. Given that only a small amount of money is generated from the VP forests, it is **ridiculous to think that its money can be used for other welfare activities in the villages**. Achieving the goal of conservation and sustainable use of VP forest in itself is a big accomplishment. Thus the VP should not be diverted to activities other than managing VP forests. (SFD) **[ST]**
5. The JFM scheme, though has a noble objective of involving people in the management of forests, did not do so in a way that would also make them independent. On the other hand through injection of one-time grant of a substantial size, it has disturbed the existing institution of Van Panchayat of Uttaranchal that was hitherto being managed by the village people from their own resources. Further, JFM does not have a successor for financing activities and this could create a void if funding is not available for the existing JFM Committees (SFD). **[ST]**
6. To accomplish the extension of the VP institution to the remaining villages of UA and other states, orientation workshops, public hearings, and meetings need to be undertaken at different levels by the states and make necessary amendments to the Forest Act. (SFDs, NGOs, MoEF) **[ST]**

Therefore, let the VPs remain the sole institution for community forest management in Uttaranchal and this model should be applied to other states of Western Himalaya, with necessary adaptive measures. If required, the positive points of JFM could be incorporated in the functioning of VPs. The villagers should be encouraged to use the revenue generated from the VP forests to further improve its quality. Incentives can be given for VPs that are well protected and external support should be largely restricted to activities that help build community ownership and build local capacity to manage forests.

Resources needed:

1. To determine adequate VP forest size (would depend upon site quality, forest type, level of degradation, population that it would support, etc.) there would be a requirement of about Rs.1 crore / yr for about 15 years.
2. One time expenditure of about Rs.5 crores would be needed for creation of VPs and the requisite training / orientation of the villagers.

Priority:

- Stop creating a parallel institution of VP, strengthen the VP institution and extend VP to the remaining areas of WHE.
- Introduce appropriate silvicultural practices.

Issue 5: Livelihood oriented conservation holds potential in both Protected Areas and outside

Keywords: Linking income generation with conservation, sustainable harvest, Himalayan alder, medicinal and aromatic plants.

Genesis:

Seeking union between money generation from biodiversity and its conservation is one of the new approaches being tried and tested in developing countries. The idea is that by sustainably harvesting biodiversity, processing the products derived from biota meaningfully (value addition), and earning money, the people can reduce acute poverty, which in turn may enable them to be more conservation-oriented. **Indeed, it is very hard to figure out the rate of sustainable harvest from natural ecosystems, and to make people to bring it in practice, and earn money from the goods.** This conservation approach needs to be tried in WH at least, where harvest of biodiversity is already going on in an inefficient way. The emphasis should be on developing products without disrupting integrity of ecosystems.

BOX 1

Livelihood opportunities from sustainable harvest of oak: A Case Study

Appropriate Technology India has carried out a unique project supported by BCN in which the main objective is to seek union between conservation of oak forest and improving people's livelihood opportunities. The main features of this success story are the following:

1. The NGO has successfully obtained the participation of very poor villagers and VPs.
2. The ecologists developed the level of sustainable harvest of oak leaves for rearing silk worms and made it socially acceptable. A monitoring institution involving representatives of several VPs is being used.
3. A number of experts on rearing silk worms using modern techniques was made out of the village people.
4. A limited Company was established in which people living in subsistence level were made shareholders. The people used to raise silk worms. All subsequent activities leading to the production of silk cloth has a substantial representation of women.
5. Naturally recruited seedlings of Quercus semecarpifolia, a major oak of Himalaya encountering regeneration problems were given protection with the participation of villagers who made a solemn promise in temples to protect and nurse the oak seedlings like their own children.

The unique combination of conservational and entrepreneurial approaches is the most distinguishing feature of this exercise.

The products may include numerous NTFPs, nature tourism, and others (Crook and Clapp 1998). It is implied that the harvest from natural systems would be sustainable and the system would remain intact. The resin extraction from pine and the trade based on it may be recognised as one of the major NTFPs based commercial activities carried out by the SFD in the Western Himalaya. In recent years community based marketing of products like tasar silk, medicinal plants, nature tourism, honey, etc. have been attempted in the Himalaya, particularly projects sponsored by BCN,

Washington. Outside India, such attempts are being carried out in several Southeast Asian counties and in tropical forests.

Strategy:

To seek union between community-based biodiversity conservation and livelihood issue.

Action:

1. Identify NGOs, village based communities, resource persons and research groups for undertaking pilot studies. In this respect the experiences of ATI at Ukhimath, Uttaranchal in which village community has been involved in tasar production (oak based silk) and the marketing of its products, and honey should be examined critically for possibility of future replication. **[MT]**

   Similarly experiences of ANSAB, Nepal in case of medicinal plants and handmade paper, and that of GBPIHED in case of ecotourism may also be analysed.

2. Certain guidelines which could be identified from past experiences and analyses throughout the world are as follows:

   a. Combine several market oriented activities for a given area. For example, from an area having oak forest near a river or lake with the backdrop of snow-clad mountains and cultivated terraces around, several commercial activities including nature tourism, collection of medicinal plants and lichens, production of tasar can be generated. In many situations one or two may not be sufficient as an alternative to other forest use or other economic activities. If activities like ecotourism are to be promoted, it is necessary to promote infrastructure to support such activities. This includes "green resorts" and also information about the ecosystem through good guidebooks and a network of information centre. (Ministry of Tourism and State Tourism Departments) **[ST]**

b. Livelihood oriented conservation should be undertaken in areas with limited alternative uses of land. Such areas are very common in Western Himalaya. **[ST]**

c. The resource density should be high so that time and energy required to collect them are convenient. For this purpose, the WH forests generally provide good material. For example, oak leaves for tasar culture are high density resource, while *Taxus* bark for taxol is a low density resource. **[ST]**

d. Activities which involve the use of plant parts such as leaves and that do not kill the whole plant are likely to be more sustainable. Researches are required to determine sustainable levels of harvest.

e. Before undertaking activities on given biotic resource the biology and ecology of species used should be comprehensively

BOX 2
Himalayan alder

Himalayan alder (*Alnus nepalensis*) is of family Betulaceae to which belongs birch (bhoj patra)

Sites colonised by alder include landslides, debris and alluvial deposits along rivers, and any other geologically young site; it does well even when drainage is poor. It is easy to establish through seeds and at least some species (e.g. red alder of NW Pacific) are propagated vegetatively.

Tripartite symbiosis- it involves alder, *Frankia* a nitrogen fixer actinomycete and mycorrhizae, both ectomycorrhiza as well as vesicular arbuscular mycorrhiza (VAM).

Alder holds a great potential as light - wood timber species. Red alder (*A. rubra*) of NW Pacific, as an example provides raw material for a thriving industry, producing furniture, cabinetry, specialized veneers and plywood, shipping pallets, turned-wood novelties, interior furniture, paper pallets and paper products. The Himalayan alder is used in house construction, and in other places where direct contact with water is not a problem. Colour stability, low shrinkage and high nail holding ability are important features of wood. In Oregon, USA 75% of the hard wood harvest was red alder in 1991. For these regions the Oregon and Washington export of alder timber to Asia has increased from zero to over 65 million broad feet in 1991, accounting for nearly 10% of the total US hard wood timber export to Asia and Europe. In USA alder provides production-time jobs to 23,500 people. There is every reason to believe that the Himalayan alder can be used in the same way as red alder, as it resembles it in many properties. Remember, even in the USA alder industry is quite recent.

Information required: Little is know about Himalayan alder, except that it is among the fastest growing species, a great nitrogen fixer (up to 200 kg ha^{-1} yr^{-1}),can attain net primary productivity in excess of 20t ha^{-1} yr^{-1} .

Research is required on the following: (1) Ascertaining plantation density for various uses. (2) Establish database on NPP and yield and N_2 fixation. (3) Ecological factors stimulating and suppressing growth in pure and mixed stands. (4) Stand dynamics both in monoculture and associated species, both broadleaved and conifers. (5) Detailed understanding of tripartite symbiosis, and biodiversity promoting activities. For these apart from plants, ectomycorrhizae and other fruiting fungi, and other microbes may be considered. (6) Ecosystem services associated with alder, such as rate of soil formation, generation of soil fertility, water filtration, facilitative role, and etc. (7) Organizing village communities to take up alder as an industry. (8) Producing useful items and marketing them.

Why alder is so suitable for Himalaya?

1. It is a disturbed sites dependent (early successional) species, and disturbances (landslides, erosion, and alluvial deposition, etc) are major and permanent feature of the Himalayan landscape.
2. Its rotation cycle is quite short and can be put to use right from 8-10 yrs.
3. It is a great N_2 fixer and a facilitator species, helping several other important timber species.
4. It is already present in large amounts

investigated and changes in field conditions monitored. Special emphasis should be given on regeneration processes. Species responding favourably to disturbances and resultant opening of the canopy are suitable species.

f. The ecological aspects should not be limited to only the species to be harvested but also to related biotic and abiotic components and functioning of ecosystems on which depend various ecosystem services. Recall the value of ecosystem services in monetary terms is enormous, exceeding US$ 33 trillion annually (Costanza *et al.* 1997).

g. Species which respond well to disturbance such as alder (*Alnus nepalensis*) and chir-pine (*Pinus roxburghii*) make very suitable material to initiate such activities (see box) in Himalayan mountains which are prone to natural disturbance. **[LT]**

h. All the uncertainties relating to access of the people to natural resources should be removed. Uncertainties may be related to change in government policy with regard to forest resource use, its transportation, and other related factors (e.g. enterprises based in *Carpinus viminea* had to suffer heavy losses subsequent to Govt.'s decision to ban tree cutting and use), exposing the entrepreneurs to high risk factors. The approach should be to anticipate the problem well in advance by considering the amount of available resource, rate of harvest, demand, regeneration processes, etc. so that such drastic changes in policy are avoided. **[MT]**

i. Enterprise based on only such species would be cost effective which have no synthetic substitutes. For example, the active compound of *Taxus* bark has no cost effective synthetic substitute. **[MT]**

j. The community maintaining and benefiting from sustainable forest use must be able to enforce exclusive rights and control over use of forest and other natural systems. VPs/forest user groups in Nepal are good examples of forest institutions. They however need o be strengthened by giving them legal support. **[MT]**

To conclude, we can imagine a forest system as an example, which has its structure and functioning intact for providing ecosystem services; supporting bird-watching and other activities of nature tourism; and from which market goods are generated by processing leaves or seeds of a tree by collecting mushrooms and morels.

The market and livelihood oriented conservation is a difficult and challenging area, requiring inputs from various experts and organisations (ecologists, economists, NGOs, state, etc.). A nodal agency at ecoregion level may be required, keeping in view the above factors, particularly relating to marketing.

Resources needed:

1. About Rs.2 crores would be required for pilot studies.
2. About Rs.1 crore would be needed for a research into the options and preparing a detailed guideline for determining the optimum combination livelihood oriented for different places.
3. About Rs.3 crores for undertaking pilot project for enterprise development. AT India could play a leading role in this field.

Priority:

1. Undertake a sufficient number of pilot studies.
2. Ensure certainty in regard to the community rights.

Issue 6: Revive natural forest regeneration, undermined during last three decades in all forestry programmes including World Bank sponsored projects

Keywords: Plus trees, selective filters, seedlings

Genesis:

Species regeneration is the very process that enables forest and grasslands to perpetuate, maintains their dynamism, and leads to selection of individuals and other evolutionary processes to take place. Regeneration of trees in natural forests was given due importance in early forestry plans of India, particularly in Western Himalaya. Troup (1921), who worked in India, was among the first in the world to describe tree regeneration of numerous forest species. However, with the initiation of plantation forestry and target-based plantation in a big way during 1970s in the plains of India, issues of natural regeneration were gradually trivialised and sidelined even in hills. Plantations are the need of plains where most of forest were cut long ago, but in hills where natural forests occur, regeneration should be given due importance (see the issue on Blanket ban on tree cutting). In subsequent decades a forestry set-up has come to be established in which not many are familiar with various management practices required to promote natural tree regeneration.

BOX 1

Plus Trees: All is not good with them

The plus trees are selected by taking all prescribed parameters of superior phenotypes, i.e., rigorously growing healthy trees, straight clean bole, wood quality, compact and narrow branching system, disease and pest resistance, thin and small branches with large branch angle, absence of forking and buttressing, good natural pruning ability, etc. A point scoring system is used.

Comment: This approach would eventually narrow down the genetic base of the species. A given character may be useful in a certain condition but may prove to be of no use in other conditions. For example, a straight bole is irrelevant in case of a fodder tree where high protein in leaves and greater foliage mass is most desirable. Similarly, the resin concentration in pine is greater in twisted trees than in straight bole trees. More allocation to roots than stem would be required on a nutrient-poor dry site. The main problem of the area is to restore forest on the bald and degraded hills with little soil and water holding capacity. Profitable plus tree forestry can be practiced only in lands where agricultural crops are grown.

The ban on tree cutting in Himalaya, which became the principal step of forest conservation, further sidelined the regeneration processes. In recent years selection and promotion of plus trees further reduced its importance. **In brief, over-emphasis on plantations, protection of individual trees to protect forests, and promotion of a few types of fast growing individuals (plus trees) have led to the trivialisation of the natural regeneration of forests.** It is possible that by planting plus trees, we may

increase productivity of a good forest site, but we cannot ignore the intensity of selection that takes place during seed germination and in initial period of seedlings life. **By ignoring selective filters consistently, we would be limiting genetic material existing within trees and around trees.**

Strategy:

Recognise natural tree regeneration as the very process for forest revival with the additional benefits of: (i) conserving both species, and intra-species genetic diversity, and (ii) saving cost of future plantation activities.

Action plan:

1. Develop a modern training course and provide training to selected foresters, NGOs, all VPs and JFMs on regeneration of trees (involve forest ecologists in universities, and persons working at - FRI, SFDs, Training Institutes. This can be done by combining efforts of the three states of WHE.) **[ST]**
2. Take-up a long-term research program and develop database, considering seed-crops, seed germination, seedling establishment and conversion to a higher age/size class (through Universities and Research Institutes of the region). Understand relationship among these and canopy gap size requirement, effect of disturbances and role of wildlife in promoting and suppressing regeneration. **[LT]**
3. **Identify the years of seed masting in various species and declare it as special event of protection** of regeneration. There are evidences to suggest that mast crops can be used to revive regeneration of all oaks and sal. **[LT]**
4. Make communities familiar with the importance and mechanism of natural regeneration, and initiate measures required to promote natural regeneration through them and NGOs. (SFDs) **[IM]**
5. Make **necessary changes in Forest Acts to include promotion of regeneration processes and protection of seedlings and saplings as part of duties of all forest users. Declare damage to regeneration even a greater crime than tree cutting**, and impose punishment legally. It is better to use a

tree, and save seedlings and saplings because one damages them unnecessarily without little gain, but at a substantial cost in the long run. (MoEF) **[LT]**

6. Identify location of sites regenerating well periodically and ensure their protection for a suitable period. Involve communities, schools and colleges in this exercise and establish demonstration plots. Let the success / failures of regeneration be used as an index of performance of the foresters (SFDs) **[LT]**
7. A community based monitoring would be required periodically. **Since most of the dominant forest tree species are common to all the three states, it would be useful pooling together of their efforts to deal with various aspects of regeneration. The three states of WHE must form a joint body to implement the aforementioned steps.** This would not only strengthen the programme but also save expenditure. Other states of India having natural forests can also adopt the programme of natural regeneration. This may lead to the establishment of national organisation for managing natural regeneration. The committee may consist of senior forest officials of the states, scientists working on regeneration issues (indicated by published documents, and field experience), and community representatives. The committee may be constituted by the MoEF with the help of state's officials, institutes and universities. Only those foresters who have experience of working in regeneration should be considered. The committee should be endowed with capacity and rights that enable it to take work from all concerned people, and contribute to capacity building at community level. Sufficient resources should be ensured to deal with the various aspects of regeneration, such as regeneration from free grazing, fire and lopping. **[LT]**

Resources needed:

1. About Rs.25 lakhs for development of course and for holding training, workshops, demonstrations, etc. involving consultants about Rs.15 lakhs per year over a period of 5 years.
2. Using Preservation Plots, PAs and experimental sites establish a forest research network of national and international stature involving the services of

scientists from different parts of the world. It would require establishment of field stations. The initial cost of the set-up would be about Rs.40 crores and would need about Rs.50 lakhs annually.

3. The database development and related research would need about Rs.10 lakhs annually.
4. The remaining could be done by the SFDs from their own resources.

Priority:

1. Make necessary changes in forest acts so as to promote natural regeneration.
2. Undertake research and train community for monitoring regeneration.

Issue 7: Restructuring and modernisation of administrative network of forest and protected areas keeping in view the needs of conservation of biodiversity (BD) and ecosystem services (ES).

Keywords: Ecological forestry, FRI and ICFRE

Genesis:

The recruitment of forest officials is open to candidates of all science streams, qualification in disciplines related to forest ecosystem studies is not required. This practice began during the colonial times when utilisation of forest and policing were the main functions of the State Forest Department. The idea is to appoint administrators on the line of civil services. The problem is that no distinction is made between the knowledge of technical and social aspects of forestry and administrative experience. The aim then is to create generalists, good at everything but experts at nothing. If administrators are given charge of silvicultural operations or are supposed to be social experts, problems will continue to occur. **But now when conservation of biodiversity and management of ecosystem services are going to be the principal goals, there is a need to orient the departmental structure accordingly.** Many changes are taking place. For example, when the state forest service came into being, PAs were not the main component of conservation, and forestry and forest ecology were not the major disciplines in Indian universities and other academic institutions.

Forms of forestry over the years

1. **Custodial Forestry** - focussed on protecting the forests from over exploitation and fire. This was practised when the forests were in abundance and level of harvest was low and natural regeneration was not a problem. Market demand was also low.
2. **Sustained Yield /Timber Production Forestry -** focussed in assuring a continuous supply of timber. In this sophisticated management was required to maintain a sustained yield of timber with a focus on rotational harvest.
3. **Multiple-Use Forestry**: In this forests are managed also for produce other than timber. Though practised from time immemorial, this management practice was codified in law recently.
4. **Production Forestry -** Focuses on intensive efforts to maximise timber production following agriculture paradigm. This started in 1960.
5. **Ecological Forestry (also called New Forestry / Forest Ecosystem Management):** In this, emphasis is placed on natural pattern and processes, understanding them, working in harmony with them, and maintaining their integrity even when it becomes financially difficult or inconvenient to do so. In this approach value of forest as a source of biodiversity and ecosystem services is of paramount importance, all others are secondary to it.

Strategy:

- Undertake the required structural changes in SFDs consistent with the system in which conservation of BD and sustenance of ES have become the overriding objectives.
- Conservation of biodiversity, ecosystem integrity and regeneration of major species of ecosystem should be included while assessing performances of foresters.

Actions:

1. Divide the state forest service between administrators and experts. While administrators could be appointed in the same manner as in the past, the experts should be appointed from different disciplines. The number of administrators should be reduced drastically, and they should not affect service conditions of the experts.
2. Recruit candidates having requisite background (MoEF) **[IM]**
   a. in disciplines relating to ecology and biodiversity for forest management,
   b. in wildlife for Protected Areas
   c. in social sciences with expertise in participatory management and specialised experience in working with the people in institution building in certain areas of the forest service where interaction with people is to be crucial. This applies in particular to the Western Himalaya where some of the village level institutions have worked effectively for several decades.
3. Provision should be for recruiting experts from different services at all stages, i.e. junior, middle, and senior level posts.
4. Orientation of the existing staff by providing refresher courses and training, etc. in the required areas as mentioned above. **[ST]**
5. **A separate department or service should be created to manage the PAs of the Western Himalayan Ecoregion and similar arrangements could be made for other regions of the country.** It could become a part of central services if such an organisation were to be developed. In addition to utilising

some of the existing personnel from SFDs in the new department about 100 persons at various levels would be needed. (MoEF) **[ST]**

6. There should be incentives for (i) good research outputs and value for applied work, (ii) providing effective services, such as taxonomists who identify organisms for the sake of others, and (iii) excelling in institution building at village level and in participatory management.
7. The FRI and ICFRE should be restructured so as to promote the cause of research. In no case generalists having inadequate understanding of research should be recruited as head of these institutions. However, administrators having excelled in generating knowledge could be allowed to join these institutions.
8. Identify ecologists and other scientists from different areas for seeking opinion on consultation basis, e.g. Dr. Rahul Kaul for pheasants, Mr. Sanjeeva Pandey for PAs, Dr. Zutshi for lake management, Prof. S.P. Singh for Forest Ecology, Drs. R.R. Rao, Y.P.S. Pangtey, G.S. Rawat and Dr. S.S. Samant for plant diversity, Dr. Lakhan Pal for mycorrhiza, etc.
9. It is important to note that the working conditions in the mountainous regions are quite different from the plains. Often the remote areas are considered as 'punishment postings'. More allowances and field equipments will have to be provided to the field staff. There is hardly any scheme for human resource development within the forest department. A devoted and qualified ranger cannot dream of attaining a higher position in the department. Such a trend also needs to be changed if the morale of the field staff has to be revamped. J&K has a separate cadre of Wildlife Department. In this state one need not qualify IFS to become a park warden or director. Any graduate with basic degree in Wildlife Science or Ph.D. in Wildlife Ecology is eligible to join the wildlife service in JK. Other states(HP and UA) need to create suitable job opportunities for the trained Wildlife Biologists/ Botanists/ Zoologists/ Ecologists in order to boost the scientific management and monitoring of forests and wildlife (SFD, MOEF, GOI) [**MT**]

10. Health of biodiversity and ecosystem services should be considered while evaluating the performance of concerned forest officials and workers.

Resources needed:

The process of change needs to be undertaken at the level of MoEF, India. It may emphasized that ecosystem should be the unit of conservation and ecological knowledge its main basis. Without proper ecological leaning, biodiversity and ecosystem services can not become the main goals of conservation.

1. About Rs.6 crores annually for the new department for managing protected areas.
2. About Rs.5 crores annually to the SFDs for sustaining the researches of the experts who are going to be the key component in the reformed Forest Service.
3. About Rs.10 lakhs annually for obtaining consultation services.

Priority:

1. Create a balanced structure of SFDs by recruiting administrators (generalists) and specialists in an appropriate proportion.
2. Create a separate service for PAs. Other actions can follow

Issue 8: Modernise management of PAs.

Keywords: Corridors, hydroscape

Genesis: PAs are important components of WH landscape accounting for about 10% of geographical area. However, their management is still primarily in the hands of administrators/generalists and the research component and monitoring are still weak.

Strategy:

Upgrade the management considering the principles of ecology and wildlife management.

Action:

1. Separate the PAs from SFDs and create a separate department for Pas, recruiting persons having expertise in wildlife and other relevant areas. [**ST**]
   For resources refer to Issue on Restructuring of Forest Service
2. Take a stock of biodiversity and develop a monitoring system using services of trained persons. [**LT**]
3. Integrate hydroscape with landscape from management point of view. Throughout the world, hydrological components which pay crucial role in the ecological functioning are ignored in PAs. There is a need to treat hydroscape as a part of terrestrial ecosystem of PAs, this may also include glaciers and changes occurring in them due to the mounting anthropogenic pressure. To start with the following steps may be taken [**LT**]:
   a. Understand the significance of water bodies for terrestrial wildlife and initiate steps for their conservation.
   b. Identify the role of vegetation along the streams as a corridor for terrestrial, aquatic and amphibian biodiversity. Often vegetation along streams are last to be lost. Therefore, it can be used to revive the vegetation of an area.
   c. Develop an understanding of the effect of water flow in higher ranges on various ecosystems of PAs located in lower ranges. For example, fish and other aquatic fauna, grasslands on floodplains.

d. Analyse the effect of pollution, including the use of pesticides in the crop fields, on the PAs and wildlife on down slopes.

e. Understand the effect of deforestation both in lower and higher ranges on regional climate and consequences on hydrology and biodiversity.

f. Analyse the interconnection across, terrestrial, riparian and aquatic ecosystem health at regional scale may be introduced for managing hyrdoscape and landscape in an integrated manner.

4. Map and develop an understanding of corridors (i) within and between the PAs, and (ii) between PAs and outside areas, especially where large mammals are important such as between India and Nepal (see the Issue of Elephant Corridors). The PAs should not be limited by state boundaries, e.g., the area Great Himalayan National Park (H.P.) can extend into northwest Uttaranchal. Services of institutes having remote sensing and GIS can be sought. [**MT**]

5. Wherever there are human settlements inside and along the periphery of PAs, effective people's participation should be sought. The role of the PA managers should be to encourage and facilitate an equal partnership, in which the knowledge, skills, traditions, and needs of local people are as much part of the management system as the formal science and practices of outside officials. Surely we need to move towards a truly joint or collaborative system of PA management which no longer treats local communities as outside the wildlife conservation system whose needs have to be met, but rather as rightful partners in the conceptualisation, implementation, and monitoring of wildlife habitats. [**LT**]

The resources needed can be estimated only on a case to case basis.

Resources:

1. For Action #2. The PA management should allocate about Rs.20 lakhs annually (see also Issue on Restructuring of Forest Service).

2. However, for actual management and conservation of these corridors would require one time grant of about Rs.5 crores plus an annual recurring expenditure of about Rs. 10 lakhs for building capacity of local people and officials on integrated land/water use management, incentives for cropping

patterns that are conducive to wildlife, empowerment of communities to enforce sustainable land/water use options, and so on.

3. Other resources needed can be estimated only on case to case basis.

Priority:

1. Promote an active participation of people and undertake periodical monitoring.
2. Integrate hydroscape and landscape in management.
3. Create a separate department/service for PAs.

Issue 9: While the blanket-ban on tree cutting in Western Himalaya has contributed significantly to save trees it has generated new forestry problems

Keywords: Chronic human disturbance, holistic approach, natural regeneration of trees.

Genesis:

The blanket ban on green tree felling above 1000 feet has been implemented strictly in Uttaranchal only while in Himachal Pradesh and J&K there are other laws which allow the local people to have access to timber. The ban on tree cutting in the WHE has led to the following problems:

1. Area and proportion of chir pine (*Pinus roxburghii*) and other conifers has increased resulting in decline in the regional biodiversity.
2. Natural regeneration of many broadleaved species has been suppressed.
3. It has pre-empted any opportunity to make progress in the development of forests based local economy, including those raised by community.
4. The unit of conservation has shifted from holistic ecosystem approach to reductionist approach of saving individual trees.

Excessive lopping of tree branches has continued in broadleaved forests, particularly of oaks, to meet the day-to-day fodder and firewood needs of the people resulting in denuded, diseased and dying trees, particularly of oaks. Conifers like pine have taken advantage of these disturbed conditions by regenerating better and expanding at the cost of broadleaved species, the regeneration of which was suppressed due to chronic human disturbance involving fodder, firewood and litter collection along with free-grazing by domestic animals and chronic fires (see the issue: Revive natural regeneration). Dead trees and fallen branches were inadequate to meet the needs of the people, resulting in illegal tree cutting.

Strategy:

Ban on green tree cutting needs to continue, but with some appropriate relaxations and modifications.

Action Plan:

1. Tree cutting in conifer forests, particularly chir pine, for generating economy both by the community and the State Forest Departments (SFDs) needs to be allowed with proper conservational and ecological measures. These species are favoured by disturbances, such as tree cutting, provided ecological principles are followed. (State Govt., VPs and JFM Committees) **[MT]**
2. Enterprise development based on timber and NTFPs should be established at community, corporate and State levels. (VPs, JFM committees, corporate houses and experts in marketing) **[LT]**
3. Ban on tree cutting in broadleaved forests in principle should continue but operations required to promote regeneration should be allowed. **[LT]**
4. Plantation forestry in productive areas (tarai, foothills, and moist and fertile sites in hills) should be taken up by VPs, JFM committees, corporate houses and SFDs. The tree cutting operations carried out to improve the economy of local community should be allowed. This may work as an incentive for raising plantations. **[LT]**
5. As far as possible whole tree cutting, which is closer to natural processes, should be in practice rather than lopping of branches. Where lopping of branches is unavoidable it should be made sustainable. For this, research on proper harvest practices would be required in consultation with forest ecologists. **[MT]**
6. Research on regeneration of broadleaved species in relation to canopy gaps and on sustainable harvest of branches should be undertaken keeping in view the ecological factors. (Scientists in Universities and Institutes, particularly known ecologists). **[ST]**
7. Emphasis on natural regeneration should be revived and it should be given the same importance as plantation in State Forestry Plans. Extension wing should be established at Universities to facilitate the task of natural regeneration. **[IM]**

8. Review of the existing forest policy and laws related to use of timber for the poor people versus mass extraction of timber for commercial purposes. (Ministry of Environment and Forests, GOI) [**IM**]

Resources needed:

The existing SFDs can be reallocated for creating awareness and operations required to promote regeneration. About Rs.50 lakhs on yearly basis would be required on a long term basis to undertake the required researches.

Priority:

Initiate understanding of natural regeneration of forest species in relation to forest disturbance and canopy gap formation.

Issue 10: Grazing is a major socio-ecological factor of the WH region and needs to be managed in an integrated way by developing an organisation of herdsmen and making it economically viable

Keywords: Alpine meadows, herdsmen, livestock, moderate grazing and species diversity, transhumance, wild herbivores.

Genesis:

Western Himalaya is India's ecoregion of snow, alpine meadows, and forests. The alpine meadows carry biodiversity different in kind and space from that of the rest of the country. In UA and HP the alpine meadows are like islands, generally surrounded by forests on the lower side and rocks and snow on the higher side, whereas, in J&K they occur in large stretches. Grazing by domestic animals (cattle, buffalo, goat, sheep and yak) of both nomads and settled populations has been a major socio-ecological factor for WH region for centuries. (The term grazing is also used to cover browsing.) Because it is also transhumance, this issue requires strategies combining efforts of more than one state.

Not all kinds of grazing can be treated as a negative factor in relation to biodiversity. Moderate grazing in grasslands is known to promote diversity and contributes to ecosystem functioning. However, grazing is generally deleterious in forests as it inhibits regeneration of trees. But, the concept of carrying capacity needs to be considered even in the case of grasslands (meaning treeless vegetation) and while doing so the demands of wild animals on the system should also be given due consideration because overstocking of domestic animals may result in overgrazing which in turn may result in a decline in the population of wild herbivores. The decline in wild

BOX 1

Overstocking in rangelands and its implications

A study in traditional agropastural system in four villages in the Spiti Valley (HP) in and around Kibber Wildlife Sanctuary has shown reduced animal production due to overstocking (Mishra *et al.* 2001). The overstocking resulted in overgrazing, which in turn has led to a marked decline in the density of wild herbivore, bharal. One of the major consequences is depredation of livestock by carnivores, and their retaliatory persecution by herders. Arrangement for alternative grazing area to reduce the stocking density can be the part of management of the sanctuary. Grazing within a limit may be useful for biodiversity conservation, but means to keep it within limit should be developed.

animal population may lead to depredation of livestock by carnivores and retaliatory action against carnivores by herdsmen.

Strategy:

Do not treat grazing as a menace, but consider carrying capacity of grazing lands for livestock, demands of wild animals and other uses of systems and socioeconomic factors while developing a plan.

Actions:

Different action plans are required for alpine and sub-alpine grasslands (generally above 3000 m), hereafter referred to as grasslands, and forested zones generally below 3000 m)

A. Grasslands

1. Given the fact that moderate grazing can promote species diversity and the economic dependence of people on livestock, blanket ban on grazing may prove to be undesirable and not required. (**MoEF**) **[IM]**
2. Carrying capacity of grasslands needs to be estimated in view of the grassland type, factors driving productivity such as rainfall and soil, population of wild animals competing for the vegetation. This particularly applies to all PAs. In addition to these, the grazing pressure of the herds on the forests while migrating to alpine meadows and returning should also be taken into account. (**To be carried out by Grassland Ecologists.**) **[ST]**

Wherever carrying capacity is likely to exceed, the livestock population should be diverted to other areas to keep the pressure within limits.

BOX 2
Migratory Graziers in HP

At present grazing permits are issued by the SFD with the sole purpose of reducing grazing pressure. Customary grazing rights also exist for pasturing of certain areas. These had been granted for generations by the Rajas of Chamba, Kangra and Kullu or these were fixed in settlement records under the British Administration.

The annual cycle of migration to alpine regions motivated the then government to adopt some measures to regulate summer migration. This led to the adoption of Kangra Forest Settlement in 1847, wherein the following parameters were outlined:

1. The flock size of each shepherd was regulated.
2. The pastures of shepherds were listed.
3. The first grazing rules were introduced in view of the pastoral cycles.

In Kangra district the shepherds meet once every year and then decide who goes where. Some of the flocks go to the same area every year while others go to different pastures.

The grazing rights to a previously unused area were given to the leading shepherd who further gave it to smaller shepherds on a fee. The practice of sub-lending which started during 1874 is still in practice in Spiti Valley.

Source: State of the Environment Report Himachal Pradesh. State Council for Science, Technology and Environment, Shimla, HP

The herdsmen are familiar with most of the meadows and of the time suitable for camping there. Using their knowledge, the movement schedule can be developed and regulated. (**Joint team of foresters from the three WH states may be formed to monitor and regulate various activities with the local assistance of herdsmen**.) **[MT]**

3. Mapping of all alpine grasslands, their size, assessment of BD and productivity in them. Almost nothing is known about the structure and functioning of alpine grasslands. With the aid of remote sensing methods they need to be mapped and categorised. They are required to be investigated for ecosystem functioning in relation to species diversity, and how their relationship is affected by livestock grazing (**one time through a research project - nodal agency can be Indian Institute of Remote Sensing, Dehradun**) **[ST]**
4. Regulation of herd size and monitoring of grassland health using indices like biodiversity and productivity. (SFDs) **[ST]**
5. Instead of charging fee from the herdsmen, they should be made responsible for regulating the herd size, protecting the meadow diversity and wild animals against illegal exploitation of medicinal plants and poaching. In order to achieve this there can be an organisation of herdsmen with legal backing in a manner similar to Van Panchayats of UA for policing the area. (**The SFDs could act as facilitators, trainers and participators in enforcing regulations.**) **[LT]**
6. In time the herder's organisation can be developed to act as nature guides for trekkers and expeditions as they are familiar with the area. Moreover, their moving camps could also be used by the trekkers and experience their lifestyle as a kind of cultural tourism. This would generate money both for the organisation and the individual members. (**NGOs, SFDs, Tourism Dept. and researchers) [LT]**

BOX 3
CHIRAG's animal husbandry programme has had success with crossbred bulls which, when mated with local cows lead to vigorous, yet fairly productive offspring. Milk yields are twice as high while calving time is quite a bit lower. At the same time these hybrid offspring can survive local conditions.

7. All herdsmen should be registered by SFDs, along with information on their herd types and size and the areas visited by them (**SFDs**) **[IM]**

B. Forests

BOX 4
Often the biggest benefit that cattle bring to local villages is by way of dung production which can be used for making compost fertiliser. If local people are interested more in dung than milk, then the very hardy local cattle make economic sense. Perhaps, the solution is to look at what crops are grown and evaluate the entire agro-economic balance.

1. There are only a few examples (like in some parts of Africa and S. America) in the world where heavy grazing of domestic animals is not considered unsustainable. Grazing (to remind, it includes also browsing) degrades forests by damaging seedlings and saplings of trees, therefore it is not sustainable in the long term. Therefore, ideally free-grazing should be replaced with stall-feeding except where because of persistent burning or some edaphic factor grasslands have been established permanently, and conversion back to forest is very costly.

There is a need to replace the present system of high stocking density of low quality animals with low stocking density of high quality animals. To support this system organised dairy with provision of adequate nutrition and marketing needs to be developed. Keeping in view the problems of terrain, climate and monetary constraints, in most situations, it may not be possible to introduce highly productive animals as Jersey cows. But, the present state of unproductive animals is also not acceptable, there is a need to bring about improvement using existing stock so that some productivity enhancement is achieved and made more economic. Often unproductive livestock is justified on the ground that it can thrive upon even unpalatable forest vegetation. But unpalatable and the so-called useless vegetation play key role in ecological functioning and in generating ecological services. From the standpoint of the forest health, unpalatability is not a negative factor, but with respect to the productivity of dairy it is. **[MT]**

The likely economic gain and reduced labour should be made the driving force to make people adopt this system rather than impose the system on them. (**Identifying proper NGOs in the initial phase would be**

important. SFDs, Animal Husbandry Dept and all Agricultural University would play the leading roles. **Concerned departments can allocate funds**)

Resources needed:

1. Research on determining the carrying capacity and associated parameters for the grasslands on the short-term basis would require about Rs.30 lakhs and using the inputs from the short-term project the mid-term project would require about Rs.50 lakhs.
2. The mapping exercise using remote sensing techniques would require about Rs.30 lakhs.
3. Money for training, workshops, etc. would initially require about Rs.1 crore later on Rs.10 lakhs or so per year.
4. Other activities could be carried out by concerned departments by reallocation of funds.
5. Long-term research projects based on ecosystem structure and functioning in relation to diversity, grazing and climatic change needs to be established. For this, certain field stations should be established.

Priority:

1. Develop database on alpine meadows having information on distribution, ecosystem features and carrying capacity.
2. Organise herdsmen.
3. Stop free grazing in forests.

Issue 11: Conservation sites outside Protected Areas (PAs), an important component of Western Himalayan Ecoregion (WHE), needs to be managed both for biodiversity and ecosystem services

Keywords: Miniature reserves, forest preservation plots, urban forests, temple forests, urban community organisation for participatory forest management.

Genesis:

Apart from nearly 10% area under PAs, the WHE still has numerous sites of natural forests and meadows, under varying levels of human pressure. Administratively, most of them are in the reserved forest and civil forests under the control of SFDs and district administration, and community forests managed variously by communities under specific guidelines formulated by the State. Then, there are numerous small patches of forests and meadows **in cantonment and urban areas, within the premises of Universities, Institutions, and Government offices. Temple forests and sacred groves** represent another kind of forests or tree collections contributing to biodiversity and ecosystem services. Many of the reserved forests, under the control of SFDs are in good shape, but degradation in them is common, particularly because of severe commercial exploitation in the past and ongoing pressure to meet the day-to-day needs of the people. It is getting obvious that even to protect government forests, people's participation is required at various levels. Many of these forest patches are located in middle elevations where there are no protected areas (Askot and Binsar Sanctuaries are exceptions) and corridors are required to connect highland with lowland protected sites.

Strategy:

Record and recognise all small forest patches outside PAs under a great variety of control/management and develop a composite plan involving all stakeholders.

Action Plan:

1. Constitute a management network (authority) involving all concerned parties (municipal boards, universities, college and school authorities, district administration, people's representatives, etc.). Record and map all urban, cantonment and sacred grove forest/meadow patches, and ecosystem features including tree species composition and wild animals (involve experts). (**SFDs**) **[ST]**

2. Make it mandatory to maintain records of regeneration status (also see the issue relating to natural regeneration), canopy cover, total tree basal area, and to develop working plan, and have them available to public (**SFDs** to follow adaptive management). **[MT]**

3. Some of these may be made available to researchers for undertaking long term investigations and for educational purposes at school and college levels. The teachers may be requested to maintain a biodiversity register. **[LT]**

4. **Create new sacred groves** (given in a separate issue) and make it compulsory for educational and scientific institutions to have biodiversity centres, based mainly on native species and crops, in the same way as provisions are being made for parking places and playing fields.

5. WHE States need to create extension wings in their universities in order to conserve biodiversity and ecosystem services in the same fashion as Agriculture Universities have extension departments for promoting agriculture practices. (**State, NGOs and related institutes**) **[LT]**

6. Maintain existing miniature reserves and develop new ones particularly in middle altitudinal zone where human pressure is high and protected areas could not be developed. Though small fragments (20-2000 ha) of vegetation may be inadequate for large mammals, they can serve the purpose of conserving populations of smaller animals and many plants and microbes. The

miniature reserves could be developed (i) on the basis of natural forests away from human settlements (e.g. Kilbury–Kunjakharak in Nainital); and (ii) by linking several patches under control of different or same administrative set-up. This may include urban areas. For example, cypress (*Cupressus torulosa*) forest (about 40 ha) on the China Peak slope of Nainital is one of the few natural cypress forests in the entire Himalaya, and can be treated as a miniature reserve. **Preservation plots** once established throughout the Western Himalaya may also be promoted as miniature reserves.

7. It is possible to develop thousands of miniature reserves, without dislocating humans. The miniature reserves may include other ecosystems such as lakes and river banks connected with the forest. In fact, a participatory management involving people, public institutions, district administration, forest department and educational centres would be required for them. Money can be generated by using them sustainably by developing NTFPs - based industries, nature tourism and for giving education to various institutions. **[50% MT - 50% LT]**

8. Establish intermediate forests in and around human settlements that may include natural forests under human use, plantations and orchards.

9. Somehow, participatory management is thought to be applicable only to village communities and has never been attempted in the urban areas. The situation in the WH region is different from other ecoregions. In this ecoregion, municipal, cantonment and nearby areas still have considerable

BOX 1
Strategy of developing Intermediate Forests

Integrate crop fields, orchards, agroforests, tree plantations and natural forest in such as way that overall land cover gives impression of an intermediate "forest type" with a mix of natural and human made components. Here the intermediate forest type includes a range of modified and transformed forest types evolved with local communities. It could be promoted in areas under the influence of human settlements

Their intermediate nature is in respect to their position between natural forest and plantations in vegetational composition, between low intensity of natural forest exploitation systems and high intensity of plantation system with selected cultivars (Wiersum and Gonzalez 2000).

The approach should be to link and nest various forms of agricultural, horticultural, plantations, and natural forests with varying degrees of mixes depending upon natural terrain, climate and socio-economic needs of communities.

Departments of Horticulture, Agriculture and Forest need to interact and develop a participatory approach to develop a balanced mix of different systems giving an overall impression of intermediate forest system so that a certain level of ecosystem services continue to flow. This would be a highly dynamic and linked system, for example, natural forests would provide litter for manuring crops and orchards. This needs a landscape or bioregional/ecoregional approach, which attempts to see entire ecological units as one, and integrate various land/water uses within this and by assessing the impacts of one use or value on the other; one also needs the central involvement of local communities, NGOs, and scientific institutions is such an approach is to work.

biodiversity and natural ecosystems warranting community participation and support for new conservation. A new kind of urban community organisation is required for participatory forest management of these forests and other ecosystems such as lakes in Kashmir and Uttaranchal.

Many of urban forests are not in good shape because of illegal and legal exploitation by the urban people, particularly during winters for keeping their houses warm. Almost no proper silvicultural practice is operative in these forests, and are faced with problems of failure of regeneration, parasite infestation, excessive lopping for firewood, fodder and construction work. Much of the disturbance is not need-based and is done by people who can afford alternative sources. Any one type of participatory approach may not work. Each one has multiple ownership like SFDs, district administration, cantonment board, municipal or institutional authorities. In certain cases there is a combined responsibility. For example, the forest is of the SFD, but in practice in the possession of a university, a school or an institute. Many times responsibilities are not well defined or no attempt has been made to define them. Purposes of these forests and importance of communication have never been outlined.

The chief strategy should be to seek cooperation of occupants and other uses without changing ownership. The owners need to be educated and trained by SFDs with the help of experts in various areas of conservation. A joint monitoring team (consisting of individuals from SFDs, controllers and experts) need to be developed to keep a watch over regeneration, exploitation and health condition. They can be treated as reserves for research and education, and put to use by educational institutions, scientists, etc. on a certain fee. They in turn help documenting all structural features and processes (species composition, mushrooms and morels, birds and animals, regeneration, tree dynamics) to be used by future workers.

Resources needed:

1. About Rs.5 crores for a period of 5 years would be required to be distributed to the different agencies involved in constituting the management network (authority).
2. About Rs.10 crores would be required over a period of 1o years for the maintenance of various records and developing a working plan.

Priority:

1. Constitute a management network involving all parties concerning with various miniature reserves.
2. Develop participatory approach for forest reserves in urban areas.

Issue 12: Strengthening Intra- and Inter-Ecoregional Co-operation for managing cross-cutting aspects of both biodiversity and ecosystem services.

Keywords: Intra- and inter-ecoregional cooperation

Genesis:

Both intra- and inter-ecoregional connections in managing biodiversity and ecosystem services are weak or non-existent largely because of sectorial administration resulting in inefficiency of management and wastage of funds. There is a need to strengthen these spatial connections.

BOX 1
Potential of apple orchards as an economic activity in view of biodiversity and other ecological factors.

HP is considered to be quite successful in generating economy through apple cultivation, and the new state of UA is suggested to follow the model. Clearly, apple orchards can be the source of much needed cash to the people. Its rotation cycle is short (but not so short for the very poor people), the labour input is low, and once established it can serve for several years. However, it has ecological costs. The pesticides used are said to have reduced the population of pollinators, particularly bees. While estimating cost benefit ration we also need to consider this ecological cost, apart from cost of wood used for fruit cases, and of the manure collected from forests. Then, damage due to year-to-year fluctuations in climate (hailstorms, droughts) can be quite discouraging.

Strategy:

The MoEF should establish Intra- and Inter-Ecoregional Cooperation Cell and undertake the following:

Actions:

A. Intra-Ecoregional

1. The time-tested institution of VP can be extended to the other two states of the ecoregion after

BOX 2
A comparative account of three ecosystems with varying degrees of human intervention.

Parameter	Agricultural crops	Apple orchards	Forests/Tree plantations
1.Soil disturbance	High	Intermediate	None
2.Nutrient and carbon loss	High, but in many traditional practices such as baranaja, where nutrients are continuously re-introduced through appropriate cropping and natural fertilisation.	Intermediate to high	Low
3.Pesticide use	Used (but none in organic agriculture)	Used	None
4.Dependency on outside energy	High (forest litter, dung/chemical fertilisers, pesticides)	High (forest energy, pesticides)	None
5.Labour	High	Intermediate	Low in natural forests where only measures to keep extraction within limits would be required; plantations may require moderate labour.
6.Rotation cycle	Very short	intermediate	Intermediate to very long
7.Minimal holding size	Small	Large	Large
8.Impact on biodiversity	Spread of invasive exotic species, but where the land is continuously tilled, impact is limited.	Decline in pollinator populations	Little
9.Money generation	Low	High	Low to high, highly variable

making appropriate changes to its structure and functioning consistent with the specific requirements of the states. For example, the condition and role of women are different in J&K than in UA. Similarly the proportion of meadows is much greater in J&K than in other states. [**LT**]

2. Establish combined cell to tackle uncontrolled exploitation of medicinal and aromatic plants, and poaching of wild animals both being similar across the three states. The two are similar and the related trades are inter-connected. This cell could include officers on deputation from various departments such as SFD, BSF, Police and members from the community, e.g. VP, Gram Panchayats from across the three WH states. This cell could be put under the direct control of MoEF so that a better interstate co-operation is achieved. Further, with the help of Ministry of External Affairs this cell could tie-up with similar or other organisations across the border for better management [**LT**]
3. Issues of global climatic change, such as changes in vegetation of timberline areas, species migration from east to west, and receding glaciers can be tackled effectively by joint efforts in the areas of research, monitoring and management. The cell will be established with the MoEF having branches in the three states of the WH, and could similarly be applied in other ecoregions. Since, these cells would be collecting information from other agencies involved in research, monitoring and management their main role will be of maintaining cooperation and coordination among these agencies. [**LT**]
4. The economic model of H.P. based on apple orchards and others needs to be examined before adopting in the other states. Impact of orchards on biodiversity and ecosystem services is particularly required to be studied. [**LT**]
5. Redrawing of PA boundaries, transhumance grazing, and development of corridors for wildlife, establishment of institutes and training centres are among areas where the three states may join hands (see the issue on Grazing). [**MT**]

B. Inter-Ecoregional (including neighbouring countries)

1. **Between WH and Gangetic Plains** for recognising the flow of ecosystem services from WH and developing a payment system (see the issue on Ecosystem Services). Corridors for upward migration of species when global warming takes place and need to be jointly developed that may particularly apply to dry deciduous forest vegetation along the river courses in the mountains which connect tropical plains, foothills, Shiwaliks and part of Lesser Himalaya and involve tree species such as *Anogeissus latifolia, Bauhnia retusa, Terminalia* spp., *Sapium insigne, Engelhardtia* spp., *Lannea grandis* and associated animal species.

BOX 3

Ecotourism in the Annapurna Sanctuary in Nepal

The major problems associated with tourism in Himalaya are that (i) profit is limited to a few rich individuals, not directly connected with the region, and (ii) it adversely affects the environment.

The Annapurna area is the most popular trekking destination in Nepal. Mass tourism in the area started in the early seventies. The impact of trekking tourism to the area's ecology and culture was realised during the early eighties, a decade after the beginning of tourism. As a response, the Annapurna Conservation Area Project (ACAP), an undertaking of the King Mahendra Trust for Nature Conservation (KMTNC), was initiated in 1986 with a pilot project in the village of Ghandruk. Tourism Management (TM) is one of many integrated conservation and development programmes of the KMTNC/ACAP. The TM Programme of the ACAP has been implemented into two modes. One is inside the Special Zone (SZ) where the ecological impacts are new and primarily due to tourism and the other is in the General Zone (GZ) where the local communities had some ecological impacts before the tourists came and added to the impacts.

The major objectives of the participatory ACA Project were (i) to maximise the communities' share in the profit from tourism that is evenly distributed, and (ii) to take measures so that tourism does not adversely affect environment and biodiversity of the sanctuary.

The tourist attractions included nature, terraced crop fields, and local cultural traits. Since the majority of the tourists visiting this area were foreigners certain minimum standards of hygiene and sanitation were desirable and hence certain programmes were undertaken, keeping in view the conservation of environment as well:

1. **Training and education of the local communities** – The importance of using local raw materials in food preparation was stressed, so much so that indigenous liquor was promoted. The community were also made aware that local nature and culture are the basis for tourism.
2. **Alternative energy programmes** – to save the forest from the use for cooking and heating a kerosene-only policy (no fuel wood use) in the Annapurna sanctuary area. Electricity from microhydel projects is also to be made available.
3. **Sanitation programmes** – were initiated to handle especially the human excreta and the non-biodegradable waste generated by tourism activities, septic tanks & incinerators were also set-up for the purpose.
4. **Institutional development** – The executive lodge management committee standardises facilities and fixes the minimum rate in the menu of all the lodges. Penalties are set for persons breaking the rules. A lodge is shared by at least two households and the partners run the lodge by taking turns. The area is also a no "mule zone"; this generates income for the porters and involves the least damage to trails.
5. **Relocation of the lodges at strategic locations** – the lodges are set-up together at one place and the distance from one site (settlement) to another has been maintained approximately between 2 to 3 hours trekkers with an experience of wilderness and at the same time providing security to the tourists.
6. **Services and information to the trekkers** – Adequate and informative signposts have been maintained along the trail.

Some interests of the ACAP discussed and passed by the assembly of the lodges owners are: (i) limiting each lodge size to a maximum of 15 beds, and (ii) shifting scattered lodges to strategic locations.

The community has a hidden rule that comes from a general consensus to allow no outsider to run a lodge in the area. If someone wants to discontinue running a lodge, he has to sell it to a local person, although this is not supported by the law.

Each lodge raises an amount of US$1500.00 a year which makes US$39000.00 for the 26 lodges in the area. The lodge owners use this money to repair and maintain the trails. This money is also used to support health, education and drinking water programmes in the village.

2. **Between WH and Nepal:** Continuous collaboration between foresters of Kumaun (UA) and Western Nepal is required to jointly deal with the following issues:
   a. Illegal trade of medicinal and aromatic plants, poaching of wild animals.
   b. Elephant corridors (refer to the Issue on Elephant corridors).
   c. Experiences and know-how of participatory forest management. The concept of forest user groups in Nepal has worked well in restoration of forest, from which India could learn.
   d. Experiences in ecotourism (see box) may be exchanged and analysed to work out a better model.

Ecotourism continued

Conclusion

For the highlands in Nepal where the opportunities for alternative livelihoods are limited, tourism is one of the available alternative livelihoods to the local communities. However, on the other hand, the fragile ecosystem of these areas may be negatively impacted by a sudden influx of tourists if it is not well planned or pre-planned. The intended economic benefits may also not be sufficient to pay for maintaining the local ecology and culture.

An integrated tourism management programme has been found effective with the experience of the KMTNC/ACAP for maximising the benefits to the local economy and ecology and minimizing the negative impacts. The KMTNC/ACAP experience shows that **strong community participation is required for effective local tourism management**. The government or the implementing NGO is to facilitate the long term vision of the tourism management programme that results from participatory planning with communities. It is very important that the vision is clearly and transparently passed on to the minds of the community. **Frequent and regular contact with the communities as a process of education is mandatory.**

3. **Between WH and China and Pakistan:**
   a. Exchange of experience and knowledge for strengthening the management of illegal trade of medicinal plants and in managing cold desert ecosystems.
   b. Combine knowledge and experiences about *Pinus gerardiana* (chilgoza) for managing wildlife associated with this important and endemic pine for improving livelihood of local communities. Experiences and knowledge may pertain to genetic diversity and selection of useful providences, distributional range, ecological tolerance, and management practices. Hitherto no attempt has been made even at scientific level in regard to such an important endemic species of the region (the region may include HP, J&K, and parts of Pakistan and Afghanistan).

Resources:

The establishment of cell at the central level with its branches in the three states would involve an initial expenditure of about Rs.1 crore and Rs.50 lakhs annually, respectively.

Priority:

1. Cooperation between WH and Gangetic Plains for recognising the flow of ecosystems services from WHE and developing a payment system.
2. Learning from the time-tested institution of VP of Uttaranchal and Forest User Groups of Nepal and extend them to other areas after due adaptive measures.

Issue 13: Providing corridor for the Western Himalayan foothill population of elephants

Keywords: Restoration of elephants' habitat, poaching, Lagga Bagga corridor

Genesis:

While habitat fragmentation may be unavoidable, it is important to (a) recognise the importance of corridors specially for megafauna (a case study of elephants is illustrative), and (b) even small forest fragments can play an invaluable role in saving microbes and fauna.

About 1000 elephants make the elephant population of Western Himalayan foothills (includes, tarai, bhabar and Shiwalik belts), ranging from Dehradun to Western Nepal, occupying sal and mixed broadleaved forests generally with *Mallotus* in undercanopy, pine mixed broadleaved forests, and grasslands distributed in them. The major problems that the elephants face are:

1. Habitat loss due to the transfer of land to other landuses and encroachment.
2. Degradation of habitats due to cutting of trees, gazing pressure of domestic animals and excessive fire.
3. Poaching
4. Fragmentation of habitats due to various factors.

Since 1960s nearly 64540 ha of habitat available for elephants has been transferred for human rehabilitation and developmental activities. Singh (2001) has estimated the grazing pressure of domestic animals of approx. 460 t of green biomass per day from the area under elephants' habitat. The human pressure on the elephant habitat can be expressed in terms of the human population that lives within 10 km of it and which is 1.17 million including about 70,000 Gujjars and other resident human populations depending on forests for their day-to-day living. Firewood collection and burning have further degraded the elephant habitats. Excessive fires along with chronic biomass removal have contributed to the spread of many coarse grasses and invasive exotic species. Elephants are frequently faced with the problems such as of poaching for ivory, death due to indiscriminate shooting and accidents (railways, electrocution by power transmission lines, etc.). Unlike other regions of India

poaching was less common in WH until recently. Due to the proximity of human settlements to the elephants' habitats, they are also under threat of being killed as they enter the crop fields. By one estimate they damage about 15% of the crops (Singh 2001).

One of the major problems is that of obstruction of the free movement of elephants across their habitats due to construction of roads, increased vehicular traffic during the last five years, construction of dams and barrages, human habitations both legal and encroachments. These obstructions have resulted in fragmentation of habitats, isolation and genetical drift.

Habitat fragmentation and degradation in the area has also resulted in the decline of other wild herbivores in the area that has also affected the tiger population in the region. The foothills of Uttaranchal form the northernmost range of distribution for Asian elephant, tiger, sloth bear and hog deer. Similarly, foot-hills of Himachal Pradesh support the northern limits of Sal forest and tiger habitat.

Strategy:

Maintenance of elephant corridor and wildlife habitat along the foot-hills of WH.

Action:

Fresh assessment of the existing corridors and proposal for revival of rapidly degrading corridors both national and international (Uttaranchal State Forest Department, Ministry of Environment & Forests, GOI, Wildlife Institute of India. International donors need to be approached for the financial aid to rehabilitate the human populations from the crucial corridor areas).

The existing corridors have problems. For example, the corridor that connects Motichur and Johara blocks to Chilla sanctuary to Duhia block is converted into a dumping place for ammunition by the army and has been used to settle the evacuated people from the Tehri dam (Singh 2001). There is a need to provide alternative corridors as given below:

1. Khamia block corridor. This includes about 2200 ha land on Khamia block near river Gaula which is under encroachment. If it is evacuated then it will serve as a good corridor for elephant migration on either side of Gaula. (SFD) **[ST]**
2. Adjacent to Khamia block there is a 500 ha government land that has been leased out. If restored, it can serve as a good corridor for migration of isolated population of elephants on the two sides of River Gaula. (SFD) **[ST]**
3. International corridor between India and Nepal. There is a need to develop Laggabagaa corridor of about 600 ha connecting Pilibhit and Sukhaphanta Sanctuary in Nepal. This would enable the movement of elephant populations from Dudhwa and Kishanpur, right up to Nepal. The tract is severely denuded due to biotic pressure. This warrants restoration. (SFD) **[LT]**
4. Animal bridges can be made wherever roads cross the path of elephant movement so that the animals can either walk under the bridge or a bridge for the animals to use and the vehicles could pass underneath them. Bridges are required at places such as to cover gaps created due to River Gaula near Kathgodam, Uttaranchal and also in areas close to Haridwar. (SFD and PWD) **[MT]**
5. The foot-hill forests of Western Himalaya, from Jammu to Sharada river need to be accorded highest priority in terms of protection and frequent monitoring (State Forest and Wildlife Departments, Indian Institute of Remote Sensing for monitoring and NGOs). [**LT**]
6. The Management Plans for the Protected Areas and adjacent forested tracts along the foot-hills need to incorporate the provisions for reduction of people-wildlife conflicts and measures to check the process of habitat degradation (State Wildlife Wings).[**LT**]

Resources needed:

About Rs.20 crores for construction of bridges and recovery processes on degraded land.

Priority:

Creation of the international corridor between India and Nepal needs to be given priority. MoEF needs to take a clear-cut stand on the maintenance of corridors and the size of elephant population (called NW elephant population of India) that can be maintained without much conflict with the people.

Issue 14: Lake eutrophication and pollution in tourist towns of Western Himalaya are affecting biodiversity and ecosystem services including water supply.

Keywords: **Watershed approach, valuation of services of lakes and watersheds**

Genesis:

The region is known for its numerous lakes, having bearing on tourism and other recreational activities, fisheries and agriculture. The lakes (including wetlands) of Kashmir such as Dal, Aanchar and Wular, and of Lake Nainital in Uttaranchal, which are major centres of tourism, are highly eutrophic and heavily polluted. They are shrinking both in area and volume, so much so that the famous Dal Lake is on the verge of ecological collapse. Until recently organic pollution was the main problem, but due to a sudden increase of vehicular traffic heavy metal pollution, particularly of lead, has become a major threat to human health. Over the years almost all plans have not considered the problem by integrating the lakes and their catchments, nor have attempts been made to evaluate the decline in ecosystem services and the cost that may be required for their restoration.

Due to extreme eutrophication, for example in Lake Nainital, about 12-15 phytoplankton species have become extinct, their species composition has shifted from more palatable to less palatable, resulting in a drastic fall in the fish population and even extinction of the famous game fish – mahasheer (*Tor tor*) and rohu (*Labeo rohita*) in the lake, from Dal Lake population of several indigenous species are disappearing including *Schizothorax esocinus*, *Bauhaunia diplostoma*, *Botia birdi*, and *Glyptothorax kashmiransis*. Among the macrophytes *Myriophyllum spicatum* and *Chara* sp. have become extinct during the last two decades.

Strategy:

Develop management plans for lake areas by using the available scientific information plans that integrating lakes and their catchments, and considering the ecological services and their economic valuation.

Action Plan:

Both curative and preventive measures are required. Since the lakes are heavily pollution and highly eutrophic they need to be treated and restored by applying methods such as:

A. Curative measures:

1. Aeration of the lake. **[IM]**
2. Deepening of extremely shallow lakes, such as Dal lake, and removal of floating islands to maintain its structure and ecological integrity. **[ST]**
3. Removal of nutrient and metal rich sediment from the lake bed (because it acts as a permanent source of pollutants). **[ST]**
4. Use of metallophytes, for the removal of nutrients by precipitation. **[IM]**
5. Biomass harvesting including that of the weed fishes. **[IM]**
6. Bio-manipulation to improve the food chain and arrest the growth of undesirable populations. **[ST]**

B. Preventive measures, mainly focussed on the catchments may include:

1. Control over input at point and non-point pollution sources. **[IM]**
2. Taking steps to direct all inputs through identifiable point sources which would be easier to handle. **[ST]**
3. Treatment of watershed, restoration of forest/grassland cover to check erosion and to increase water retention, maintenance of spring points and areas that filter water (such as valley fills), creation, upgradation and maintenance of drainage, sewer and waste disposal system, estimation of carrying capacity of the watershed, especially from the standpoint of tourist activities, control of vehicular traffic. Water treatment costs less when watershed is treated properly (see example of New York). Such treatment of watershed generates several other services such as filtration of water, air, carbon sequestration, control over erosion and siltation, recreational value, etc. **[ST]**
4. Valuation and monitoring of all the services of the watershed and lake ecosystems and of their degradation or of not maintaining them. The valuation may pertain to recreational value of water – fishing, bird watching, swimming,

boating and other water sports, aesthetic, filtration of water, pollution abatement through forests, etc. **[LT]**

5. To discourage pollution in future "polluter pays" principle should be applied and mechanism to impose fines and use the money generated for lake conservation and treatment. Also a kind of cess may be imposed on tourists for keeping a regular fund to be used for continued maintenance of lakes.

Agencies to be primarily entrusted with the work – separate lake development authorities such as J&K Lakes and Waterways Development Authority and Lake Area Development Authority (Nainital, Uttaranchal) should be entrusted with the above responsibilities jointly with other bodies such as Municipality, Pollution Board, PWD, etc. in consultation with the experts in lake ecology.

Resources needed:

1. Operation of machines needed for curing and purging activities and technical consultants and experts such as aquatic ecologists, geologists, engineers, etc. Rs.40 crores.
2. Item nos. 3 & 4 under preventive measures would require about Rs.15 crores.

Priority:

Undertake curative measures immediately and prepare a long-term plan by implementing preventive measure.

Issue 15: Conservation of dry deciduous biome along the xeric slopes of the river and watercourses

Keywords: Xeric vegetation on slopes along river courses.

Genesis:

Throughout the WH region on the steep slopes along the rivers a desert like vegetation dominated by deciduous species and evergreen palms and cactus like plants (*Euphoria royalina*) has established. Several tropical species are able to intrude deep into the mountains through the river courses e.g. *Malotus, Erythina, Anugius, Bahunia, Sepium, Marmatus,* etc. Though occupying large areas in the region, this biome is generally ignored from the management point. The slopes are either loose or are extremely rocky and highly fragile in the absence of vegetal cover. Anthropogenic pressure has degraded them further. Since habitat of this vegetation is directly connected with rivers, it is the principal source of silt load. Keeping in view the importance of hydrological systems these special sites should be allowed to be restored through natural succession. Since people do not get much out of these degraded vegetation they should be kept free from any kind of vegetal use and should be designated as a kind of sanctuary area.

Strategy:

River courses and areas where such vegetation occurs should be mapped and kept away from human use.

Actions:

1. Using appropriate methods record spatial distribution of riverside deciduous forests their characteristic species, growth forms and the amount of biodiversity. (SFD in consultation with vegetation ecologists) [**ST**].
2. Investigate forest structure and function processes in particular reference to hydrology and the role of this vegetation containing river slope erosion and mast-wasting. Investigate the corridor values of these biomes. [**MT**]

3. Keeping in view the important role of plant cover in controlling slope erosion and resulting siltation of river beds, it should be kept free from any commercial or day-to-day use. Only some medicinal plants or other plants of high economic value could be harvested keeping in view sustainability. There should be blanket ban on fire in these areas even as a management practice [**LT**].
4. Due to recurring erosion and human disturbances the system remains arrested at early successional stage. The management practices should see that succession progresses to later stages. This biome requires substantial restoration work using both bio- and civil-engineering technologies for stabilisation of slopes and allowing natural progression of succession. Researches would also include restoration techniques [**MT**].

Resources:

1. For research, experts from universities, institutes and SFDs could be used. A 5-10 yr research project needing about Rs.30 lakhs annually would be required.
2. Restoration work would require inputs from various departments, e.g., SFDs, PWD, universities and institutes and would involve an expenditure of about Rs.30 crores annually.

Priority:

Pay attention to restoration of this biome established on immature and highly fragile hill slopes and which has never been recognised even listed in any management plan.

Issue 16: Impact of global warming on biodiversity

Keywords: Refugia for woody species, species migration.

Genesis:

1. WH would provide the refugia for woody species marching upward due to the rise in temperature.
2. Greatest threat would be to the forests making the timber line or just below such as kharsu oak (*Quercus semecarpifolia*), silver fir (*Abies pindrow*), and bhojpatra (*Betula utilis*) which already occur as islands. These forests have occurred in large areas during one of the previous glaciations but are already on the move towards higher altitudes during the last several thousand years.
3. Many species including these would move from east to west in search of cooler habitats but because of their island like distribution and anthropogenic pressure their natural movement would almost be impossible. This applies particularly to species *Q. semecarpifolia* which is viviparous (seed germination taking place while seeds are still on tree as a consequence of which it perishes if it doesn't find appropriate condition at the microsite at the moment it falls to the ground) (Singh *et al.* 1997).

BOX 1
Effect of Global Climatic Change

A recently conducted study on tree ring width of blue pine (*Pinus wallichiana*) in the Western Himalaya indicated 42-47% higher tree growth at different sites during the second half of the 20th century compared to the first half (Yadava and Bera, 2002), largely because of atmospheric CO_2 fertilisation. Since other species, *viz*., silver fir, deodar and Himalayan yew did not show positive response to CO_2 fertilisation, expansion of blue pine at the expense of the other conifers is likely to occur as atmospheric CO_2 concentration increases in future. In fact, this study emphasises that vegetational changes in Western Himalaya have already occurred under the influence of atmospheric CO_2 fertilisation.

Action:

1. Assist the species migrating in the search of suitable sites. Assistance does not mean transferring a forest from one place to another physically. The forest destruction due to climatic change is expected to occur over several decades. What humans can do is assist the migrating species in their process of establishment in favourable areas. For example, seedling establishment can be promoted by transferring seeds to favourable microsites, or seedlings recruited

could be helped to become trees. Management can help by restricting the loss due to grazing or burning of species during its migration and requirement in new sites. WH, in particular J&K, is an important area from the standpoint of biodiversity management feature. (SFDs, Universities, NGOs, Institutes, and village community) [**LT**]

2. Continuous monitoring of species movement, changes in vegetation (such as colonisation of meadows by woody species), receding of glaciers, and changes in water flow should be undertaken. Eventually the monitoring has to be community based, since they are the ones dealing with vegetation in their day to day life, and are observing the changes. Some orientation on regular or systematic monitoring would probably yield a lot of valuable information from them. However, scientific studies would be required to make an effective prediction of possible impact. The idea is to monitor the track of migrating species and give a hand in support to protect them from additional stress due to anthropogenic pressure(Scientists, SFDs, Research Institutes and members of the community) [**LT**]
3. **Research.** WHE should be made a part of global research network. Changes due to global warming and CO_2 enrichment need to be investigated. For this timberline ecosystems and adjacent crop-fields make particularly suitable material.

Resources:

1. Once the microsites for migrating species are identified the establishment of the species could be achieved by the SFD with the aid of village communities and NGOs. This process could involve about Rs.5 crores per microsite.
2. The monitoring process may be undertaken in the form of a long term project and would involve about Rs.15 lakhs annually since most of the monitoring could be achieved through the SFDs.

Priority:

1. Monitoring the changes occurring under the influence of global warming and keeping a record of the track taken by the migrating species.
2. Facilitating the establishment of species migrating in search for suitable sites.

Additional Strategies for J&K

Startegies oriented for the needs of J&K are as follows:

a. Strengthen the existing institutions carrying out biodiversity related work.
    i. Strengthen research institutions like Centre of Research for Development (CORD), Centre of Plant Taxonomy (CoPT). CoPT in the University of Kashmir is committed to studies on floristic diversity of J&K and harbours a well kept herbarium with a collection of about 1 lakh specimens. It is also involved in ex-situ conservation of some plant species in its Botanical garden.
    ii. Improve state departments like the State Forest Research Institute and the Wildlife Department so that forest and wildlife resources are managed better.
b. Address Gaps in knowledge: Certain new research projects may be carried out in the state to improve our knowledge of biological diversity of the state:
    i. Inventorisation of biological diversity of the state and an assessment of the status of various taxon groups leading to formation of a database on the biological resources of the state.
    ii. Research on ecosystem structure and function.
        1. Aquatic and wetland ecosystems; and bio-magnification
        2. Global warming in relation to snow cover and alpine meadows.
        3. Forest and pastureland ecology.
    iii. Research, *in-situ and ex-situ* conservation of threatened species.
        1. Landscape based conservation of Hangul, Western Tragopan.
        2. Ex-situ conservation of Musk deer, Chiru and important medicinal plants.

3. Ex-situ conservation of landraces of rice, wheat and fruits and certain threatened fish species.
4. Impact of invasive species of plants (weeds and exotic timber species) on the native fauna.

c. Formation and strengthening of village level institutions: The village level institutions are basic mechanisms to conserve biodiversity at the grassroots level. The inadequate system of village level institutions in J&K is seen as one of the main reasons for lack of awareness about the issues and any meaningful conservation activity on the ground. Expeiences of Uttaranchal with regard to participatory management of forests may be extended with necessary modifications. Certain actions are therefore proposed:
   i. Strengthen Village Panchayats and include them in decision making about resource management of their areas.
   ii. Formation of local eco-groups to act as an interface between the government and the people.
   iii. Formation of a Biodiversity Assessment Group comprising of scientists, conservationists, policy makers and administrators.

d. Policy: Globalisation has affected environmental issues to a great extent. Therefore the state policies need to be reviewed in that light as well as new scientific findings.
   i. Agriculture support policy: The agriculture policy of the state may be modified to include incentives for cultivation of low yielding but important land races of crops and horticulture. The policy also needs to be ammended so that a wider variety is offered to the farmers for cultivation. This will broaden the genetic base in agricultural and horticultural biodiversity.
   ii. Review of Biodiversity law: In view of the article 370 of the Indian Constitution prevailing in the state of J&K, the newly introduced Biodiversity law will have to be viewed from the point of view of the state.

iii. Fisheries Act: A review of the Fisheries prevailing in the state is suggested to curtail indiscriminate fishing pressure and practice.

iv. Forest Act: Farm grown trees may be treated as extended agriculture under social forestry to encourage growth of economically important tree species. Fire wood and timber sale depots policy may be re-examined especially with regard to people living close to Protected Areas.

v. Trade: The ban on Shahtoosh manufacture and sale has been announced by the state government. In case of a formal order being issued by the government in this regard, there is urgent need to draft a comprehensive rehabilation programme for those affected by the ban. Policies should also look at streamlining the trade of endangered species of plants so that it is made more sustainable and benefits accrue to the locals rather than the middlemen.

vi. Natural Springs: The state has a preponderance of natural springs, some of which are traditionally protected because of religious reasons. As springs provide an important source of water for the people, all springs must be protected under law so that important water sources are secured.

vii. Pollution: Solid waste management needs to be strengthened. Banning the use of non-biodegradable materials (like polythene) should be strictly enforced to save the lakes from choking.

Recommendations for J&K

Actions to Strengthen Institutions

- Formal Education (Action – Universities/Institutes)

  Elementary Level – Reading and Audio Visual Aids

  Secondary Level – Curriculums, formal reading and Electronic Media

  Tertirary Level - Theme wise/development of technology

- Non-formal Education (Action – Gos/NGOs/Volunteers)

  Village Community – Practical examples with Acts/resolution

  Household level – Awareness and elementary level of rights and rules

  School/College Level – Information transmission of technology developments

- Community Bodies/Structural Development (Action – GOs/NGOs)

  Local Institutions – *Jal Samiti* (Drinking water)

  (Distribution of powers for the conservation of water bodies/resources for the community level)

  Van Samithi/Rakshak (Forest Conservation)

  (Legalising the *Van Samithi/sansthan* rights for the conservation of the forest by local bodies)

  Sawasth Prabandhak (Health Clubs)

  Siksha Prashad/Praud Siksha Prashad (Education is must – at all levels)

  Krishi Panchayat (Agriculture)

  Sanchar Samithi (Communications)

(The entire rights and the recommendations should be meant considering the local requirements and infrastructure available. The local people specially women should have complete participation in the law making and contribution for the sustainability of the committees. The nodal persons of the committees should be from the local communities and women should be have special reservations for that. The equity powers and rights should be given for the smooth running of the programs).

The strategies to build bridges for crisis of the biodiversity (Academicians/GOs/NGOs).

- Enabling wider sharing of information and understanding regarding the current crisis.
- Facilitating widespread dialogue amongst diverse sectors of society and to address the crisis
- Enable a response to specific incidences of destruction of wildlife and erosion of livelihood rights.
- Promote the sensitization of environmental conservation towards social issues and of social activists to wards conservation requirements and
- Facilitated responses to national level policy and legal mechanism that impact on wildlife and local communities.

Causes of the serious concerns of the biodiversity (Policy Makers/NGOs)

- The policies for the market domination and more centralized regulations
- Commercialization for the current process of developments
- People's livelihood rights are overtaken be the national cum economic policies
- Need to build a system that integrates biodiversity conservation

Monitoring Strategy/Action Plan (Academicians/Policy Makers)

- Extensive documentation of the available natural resources and the economic value should be carried out for the entire region at 1:50,000 scale.
- The annual monitoring of the natural resources and the database building should be carried out in the regional scale (1:1000,000) using aerospace technology.
- The conflict areas should be dealt in detail using high resolution data..
- Ground level studies should be done for the critical areas.
- The development activities should be carried out using the aforesaid database after execution of the predictive models successfully.
- The performance appraisal of the areas should be carried out and appropriate award should be given to the local bodies for the improved area.

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NATIONAL BIODIVERSITY STRATEGY & ACTION PLAN
WESTERN HIMALAYAN ECOREGION

Appendix 1

Mammals of Jammu and Kashmir State

S. No.	Common Name	Scientific Name
1.	Pale Grey Shrew	*Crocidura pergirisea*
2.	Brown Musk Shrew	*Crocidura murina tyleri*
3.	Kashmir vampire	*Megaderma spectrum*
4.	Lesser Horse-shoe Bat	*Rhinolophus hipposideros midas*
5.	Greater Horse-shoe Bat	*Rhinolophus ferrumequinum*
6.	Leisler's Hairy-armed Bat	*Nyctalus leisleri*
7.	Common Noctule	*Nyctalus montanus*
8.	Serotine	*Eptesicus serotinus pachyotmus*
9.	Theobalt's Bat	*Vespertilio murinus*
10.	Rhesus Macaque	*Macaca mulata villosa*
11.	Kangra Langoor	*Presbytis entellus ajax*
12.	Kashmir Leopard	*Panthera pardus millardi*
13.	Indian Leopard	*Panthera pardus fusca*
14.	Snow Leopard	*Uncia uncia*
15.	Trevelyan's Leopard Cat	*Felis bengalensis travelyani*
16.	Jungle Cat	*Felis chaus affinis*
17.	Himalayan Lynx	*Lynx lynx isabellina*
18.	Pallas's Cat	*Felix manul manul*
19.	Red Manul	*Felis manul nigripecta*
20.	Common Palm Civet or Toddy Cat	*Paradoxurus hermaphroditus vellerosus*
21.	Small Indian Mongoose	*Herpestes auropunctatus auropunctatus*
22.	Tibetan Wolf	*Canis lupus chanco*
23.	Indian Jackal	*Canis aureus*
24.	Hill Fox	*Vulpes vulpes montana*
25.	Trans Himalayan Wild Dog	*Cuon alpinus laniger*
26.	Himalayan Brown Bear	*Ursus arctos isabellina*
27.	Himalayan Black Bear	*Selenarctos thibetanus laniger*
28.	Kashmir Otter	*Lutra lutra kutab*
29.	Beech Marten	*Martes foina intermedia*
30.	Yellow-thorated Marten	*Martes flavigula flavigula*
31.	Stoat or Ermine	*Mustela erminea ferghanase*
32.	White-footed Weasel	*Mustela altaica temon*
33.	Hodgson's Weasel	*Mustela sibrica hogsoni*
34.	Tibetan Pole Cat	*Putorius putorius larvatus*
35.	Western Kiang	*Equus Kiang kiang*
36.	Wild Boar	*Sus scrofa*
37.	Hangul or Kashmir Stag	*Cervus elaphus hanglu*
38.	Cheetal	*Axis axis*
39.	Himalayan Musk Deer	*Moschus crysogaster leucogaster*
40.	Barking Deer	*Muntiacus muntjak*
41.	Wild Yak	*Bos grunniens grunniens*

42.	Flare-horned or Astor Markhor	*Capra falconeri falconeri*
43.	Pir Panjal Markhor	*Capra falconeri cashmiriensis*
44.	Himalayan Ibex	*Capra ibex sibrica*
45.	Five-stripped Squirrel	*Funambulus pennanti*
46.	Himalayan Marmot	*Marmota bobak himalayana*
47.	Long-tail Marmot	*Marmota caudata caudata*
48.	Royle's High Mountain Vole	*Alticola roylei roylei*
49.	Blanford's High Mountain Vole	*Alticola roylei blanfordii*
50.	Montasa's High Mountain Vole	*Alticola roylei montasa*
51.	Glacial Vole	*Alticola roylei glacialis*
52.	Stoliczka's Vole	*Alticola stoliczkanus*
53.	Little Grey Hamster	*Cricetulus migratorius*
54.	Ladakh Hamster	*Cricetulus alticola*
55.	Muree Vole	*Hyperacrius wynei*
56.	True's vole	*Hyperacrius fertilis*
57.	Blyth's Vole	*Pitymus leucurus*
58.	Yellow-necked Field Mouse	*Apodemus flavicalis wardi*
59.	Kashmir House Rat	*Rattus rattus slugarius*
60.	Common House Rat	*Rattus rattus rattus*
61.	Short-tailed Bandicoot Rat	*Nesokia indica indica*
62.	Birch Mouse	*Sicista indica*
63.	Large-eared Pika	*Ochotona macrotis*
64.	Ladakh Pika	*Ochotona ladacensis*
65.	Royle's Pika	*Ochotona roylei*
66.	Nubra Pika	*Ochotona nubra*
67.	Woolly Hare	*Lepus oistolus*
68.	Crested Porcupine	*Hystrix indica*

Appendix 2

Birds of Jammu and Kasmir State

S.No.	Common Name	Scientific Name
1.	Great Crested Grebe	*Podiceps cristatus cristatus*
2.	Indian Little Grebe	*Podiceps ruficollis capensis*
3.	Indian Shag	*Phalacrocorax fusicollis*
4.	Indian Large Cormorant	*Phalacrocrorax carbo sinensis*
5.	Eastern Grey Heron	*Ardea cinerea rectirostris*
6.	Pond Heron or Paddybird	*Ardeola grayii*
7.	Large Egret	*Egretta alba*
8.	Night Heron	*Nycticorax nycticorax nycticorax*
9.	Little Bitten	*Ixobrychus minutus minutus*
10.	Bittern	*Botaurus stellaris stellaris*
11.	White-fronted Goose	*Anser albifrons*
12.	Lesser-fronted Goose	*Anser erytropus*
13.	Greyieg Goose	*Anser anser rubrirostris*
14.	Bar-headed Goose	*Anser indicus*
15.	Whooper Swan	*Cygnus cygnus*
16.	Ruddy Shelduck	*Tadorna ferruginea*
17.	Common Shelduck	*Tadorna tadorna*
18.	Marbled Teal	*Marmaronetta angustiristris*
19.	Pintail	*Anas acuta*
20.	Common Teal	*Anas creacca crecca*
21.	Mallard	*Anas platyrhynchos platyrhynchos*
22.	Gadwall	*Anas stepera*
23.	Wigeon	*Anas penelpoe*
24.	Garganey	*Anas querquedula*
25.	Shoveller	*Anas clypeata*
26.	Red-crested Pochard	*Neeta fufina*
27.	Common Pochard	*Aythya ferina*
28.	Ferruginous Duck	*Aythya nyroca*
29.	Tuffed Duck	*Aythya fuligula*
30.	Scaup Duck	*Aythya marila*
31.	Nukta or Comb Duck	*Sarkidiornis melanotos*
32.	Goldeneye	*Bucephala clangula*
33.	Goosander	*Mergus merganser orientalis*
34.	White-headed Duck	*Oxyura leucocephala*
35.	Black-winged Kite	*Elanus caeruleus vociferus*
36.	Siberian Honey Buzzard	*Pernis ptilorhynchus orientalis*
37.	Black-eared Kite	*Milvus migrans lineatus*
38.	Pariah Kite	*Milvus migrans govinda*
39.	Red Kite	*Milvus milvus*
40.	Goshawk	*Accipiter gentilis schvedowi*
41.	Indian Sparrow Hawk	*Accipiter nisus melaschistos*
42.	Northern Basra Sparrow-hawk	*Accipiter virgatus affinis*
43.	Long-legged Buzzard	*Buteo ruffinus ruffinus*
44.	Booted Eagle	*Hieraaetus pennatus*

45.	Himalayan Golden Eagle	*Aquila chrysaetos daphanea*
46.	Steppe Eagle	*Aquila ropax nipalensis*
47.	Pallas's Fishing Eagle	*Haliaeetus leucoryphus*
48.	Aegypius monachus	*European Black or Cinereous Vulture*
49.	Himalayan Griffon Vulture	*Gyps himalayensis*
50.	Indian Long-billed Vulture	*Gyps indicus tenuirostris*
51.	Indian White-backed Vulture	*Gyps bengalensis*
52.	Egyptian Vulture	*Neophron percnopterus percnoterus*
53.	Lammergeier or Bearded Vulture	*Gypaetus barbatus aurens*
54.	Pale Harrier	*Circus macrourus*
55.	Monragu's Harrier	*Circus pygargus*
56.	Marsh Harrier	*Circus aeruginosus aeruginosis*
57.	Short-toed Eagle	*Circaetus Gallicus gallicus*
58.	Osprey	*Pandion haliaetus haliaetus*
59.	Saker Falcon	*Falco biarmicus chrrug*
60.	Peregrine	*Falco peregrinus*
61.	Central Asian Hobby	*Falco subbuteo centralasie*
62.	Merlin	*Falco columbarius*
63.	Kestrel	*Falco tinnunculus*
64.	Tibetan Snowcock	*Tetraogallus tibetanus tibetanus*
65.	Himalayan Snowcock	*Tetraogallus himalayensis himalayensis*
66.	Tibetan Chukar Partridge	*Alectoris chuckar pallescens*
67.	Common Chukar Partridge	*Alectoris chukar chukar*
68.	Indian Black Partridge	*Francolinus francolinus asiae*
69.	Tibetan Partridge	*Perdix hodgsoniae hodgsoniae*
70.	Ladakh Partridge	*Perdix hodgsoniae caraganae*
71.	Common Grey Quail	*Coturnix coturnix coturnix*
72.	Jungle Bush Quail	*Perdicula asiatica*
73.	Western Tragopan	*Tragopan melanocpehalus*
74.	Himalayan Monal	*Lophophorus impejanus*
75.	White-crested Kaleej	*Lophura leucomelana hamiltoni*
76.	Kashmir Koklas	*Pucrasia macrolopha castanea*
77.	Common Koklas	*Pucrasia macrolopha biddulphi*
78.	Cheer Pheasant	*Catreus wallichii*
79.	Red Junglefowl	*Gallus gallus*
80.	Indian Peafowl	*Paca cristatus*
81.	Demoiselle Crane	*Anthropoides virgo*
82.	Black-necked Crane	*Grus nigricollis*
83.	Turkestan Water Rail	*Rallus aquaticus korejewi*
84.	Corn Crake	*Crex crex*
85.	Northern Ruddy Crake	*Porzana fusca fusca*
86.	Eastern Baillon's Crake	*Porzana pusilla pusilla*
87.	Indian Moorhen	*Gallinula chloropus indica*
88.	Indian Purple Coot	*Porphyrio porphyrio poliocephalus*
89.	Coot	*Fulica atra atra*

90.	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*
91.	Painted Snipe	*Rostratula benghalensis benghalensis*
92.	Black-winged Stilt	*Himantopus himantopus himantoupus*
93.	Ibisbill	*Ibidorhyncha strithresii*
94.	Collard Pratincole	*Glareola partincola*
95.	Lapwing or Peewit	*Vanellus vanellus*
96.	Redwattled Lapwing	*Vanellus indicus*
97.	Eastern Golden Plover	*Pluvialis dominica fulva*
98.	European Little Ringed Plover	*Chradrius dubius curonicus*
99.	Charadrius alexandrinus	*Kentish Plover*
100.	Lesser Sand Plover	*Charadrius mongolus adtrifrons*
101.	Common Curlew	*Numenius arquata*
102.	Common Redshank	*Tringa totanus totanus*
103.	Marshsandpiper	*Tringa stagnatilis*
104.	Greenshank	*Tringa bebularia*
105.	Wood Sandpiper	*Tringa glareola*
106.	Greensandpiper	*Tringa ochropus*
107.	Common Sandpiper	*Tringa hypoleucos*
108.	Solitary Snipe	*Gallinago solitaria solitaria*
109.	Pintail Snipe	*Gallinago stenura*
110.	Fantail Snipe	*Gallnago gallinago gallinago*
111.	Woodcock	*Scolopax rusticola rusticola*
112.	Little Stint	*Calidris minuta*
113.	Temminck's Stint	*Calidris temminckii*
114.	Curlewsandipiper	*Calidris testacea*
115.	Ruff and Reeve	*Philomachus pugmas*
116.	Red-necked Phalarope	*Phalaropus lobatus*
117.	Great Black-headed Gull	*Larus ichthyaetus*
118.	Brown-headed Gull	*Larus brunnicephalus*
119.	Little Gull	*Larus minutus*
120.	Indian Whiskered Tern	*Childonias hybrida indica*
121.	White-winged Black Tern	*Childonias leucopterus*
122.	Common Tern	*Sterna hirundo*
123.	Little Tern	*Sterna albifrons*
124.	Arctic Tern	*Sterna paradisaea*
125.	Gull-billed Tern	*Gelochelidon nilotica*
126.	Tibetan Sandgrouse	*Syrrhaptes tibetanus*
127.	Nepalese Snow Pigeon	*Columba leuconota leuconota*
128.	Blue Rock Pigeon	*Columba livia*
129.	Hill Pigeon	*Columba rupestris turkestanica*
130.	Speckled Wood Pigeon	*Columba hodgsonii*
131.	Rufous Turtle Dove	*Stretopelia orientalis orientalis*
132.	Western Turtle Dove	*Streptopelia orientalis meena*
133.	Indian Ring Dove	*Streptopelia decaocto decaocto*
134.	Indian Little Brown Dove	*Streptopelia senegalensis camboyensis*
135.	Indian Spotted Dove	*Streptopelia chinensis suratensis*
136.	Himalayan Slaty-headed	*Psittacula himalayana himalayana*

	Parakeet	
137.	Rose-ringed Parakeet	*Psittacula krameri*
138.	Northern Pied-crested Cuckoo	*Clamator jacobinus serratus*
139.	Asiatic Cuckoo	*Cuculus canorus canorus*
140.	Himalayan Cuckoo	*Cuculus saturatus saturatus*
141.	Small Cuckoo	*Cuculus poliocephalus policephalus*
142.	Koel	*Eudynamys scolopacea*
143.	Indian Brown Owl	*Tyto alba sterten*
144.	Great Horned Owl	*Bubo bubo*
145.	Western Himalayan Barred Owlet	*Glaucidium cuculoides cuculoides*
146.	Western Collared Pigmy Owlet	*Glaucidium brodiei brodiei*
147.	Little Owl	*Athene noctua*
148.	Long-eared Owl	*Asio otus otus*
149.	Short-eared Owl	*Asio flammeus flammeus*
150.	Scully's Wood Owl	*Strix aluco biddulphi*
151.	Eurasian Nightjar	*Caprimulgus europaeus unwini*
152.	Indian White-throated Spinetail Swift	*Chaetura caudacuta nudipes*
153.	Alpine Swift	*Apus melba*
154.	Eastern Swift	*Apus apus pekinensis*
155.	Blyth's White-rumped Swift	*Apus pacificus leuconyx*
156.	Common Indian House Swift	*Apus affinis affinis*
157.	Himalayan Pied Kingfisher	*Ceryle legubris guttulata*
158.	Indian Lesser Pied Kingfisher	*Ceryle rudis leucomelanura*
159.	Central Asian Kingfisher	*Alcedo atthis pallasii*
160.	White-breasted Kingfisher	*Halcyon smyrnensis smyrnensis*
161.	European Bee-eater	*Merops apiaster*
162.	Blue-cheeked Roller	*Merops superciliosus persicus*
163.	Kashmir Roller	*Coracias garrulus semanowi*
164.	Indian Roller	*Coracias benghalensis*
165.	European Hoopoe	*Upupa epops epops*
166.	Great Hill Barbet	*Megalaima virens*
167.	Wryneck	*Jynx torquilla*
168.	Scaly-bellied Green Woodpecker	*Picus squamatus squamatus*
169.	Kashmir Pied Woodpecker	*Picoides himalayensis albescens*
170.	Western Brow-fronted Pied	
171.	Short-toed Lark	*Calandrella cinerea*
172.	Hume's Short-toed Lark	*Calandrella actirostris*
173.	Bimaculated Lark	*Melanocoryha bimuculata torquata*
174.	Ladakh Long-billed Lark	*Melaocorypha maxima*
175.	Long-billed Horned Lark	*Eremophila alpestris longirostris*
176.	Kashmir Sky Lark	*Alauda gulgula Ihamarum*
177.	Plain Sand Martin	*Riparia paludicola chinensis*
178.	Crang Martin	*Hirundo rupestris*
179.	Wire-tailed Swallow	*Hirundo smithii filifera*

180.	Common Swallow	*Hirundo rustica rustica*
181.	Temminck's Red-rumped Swallow	*Hirundo daurica rufula*
182.	Kashmir House Martin	*Delichon urbica cashmirensis*
183.	Lesser Grey Shrike	*Lanius minor*
184.	Red-backed Shrike	*Lanius collurio*
185.	Ladakh Grey-backed Shrike	*Lanius tepronotus lahulensis*
186.	Rofous-backed Shrike	*Lanius schach eryhronotus*
187.	Golden Oriole	*Oriolus oriolus kundoo*
188.	Himalayan Black Drongo	*Dicrurus adsimilis albirictus*
189.	Grey or Ashy Drongo	*Dicrurus leucophaeus longicaudatus*
190.	Brahminy Myna	*Sturnus pagodarum*
191.	Starling	*Sturnus vulgaris*
192.	Common Myna	*Acridotheres tristis tristis*
193.	Jungle Myna	*Acridotheres fuscus*
194.	Black-throated Jay	*Garrulus lanceolatus*
195.	White-rumped Magpie	*Pica pica*
196.	Western Himalayan Tree Pie	*Dendrocitta formosae occidentalis*
197.	Large Spotted Nutcracker	*Nucifraga caryocatactes multipunctata*
198.	Nutcracker	*Nucifraga caryocatactes hemispila*
199.	Red-billed Chough	*Pyrrhocorax pyrrhocorax*
200.	Yellow-billed Chough	*Pyrrhococrax graculus*
201.	Sind House Crow	*Corvus splendense zugmayeri*
202.	Rook	*Corvus frugilegus frugilegus*
203.	Jackdaw	*Corvus monedula monedula*
204.	Himalayan Jungle Crow	*Corvus macrorhynchos intermedius*
205.	Eastern Carrion Crow	*Corvus corone orientalis*
206.	Tibetan Raven	*Corvus corax tibetanus*
207.	Long-tailed Minivet	*Pericrocotus ethologus*
208.	Indian Short-bille Minivet	*Pericrocotus brevirostris brevirostris*
209.	White-cheeked Bulbul	*Pycnonotus leucogenys*
210.	Himalayan Black Bulbul	*Hypsipetes madagascariensis psaroides*
211.	Sind Jungle Blabbler	*Turdoides striatus sindianus*
212.	Western White-throated Laughing Thrush	*Garrulax albogularis whistleri*
213.	Western Varigated Laughing Thrush	*Garrulax variegatus similis*
214.	Kumaon Rufous-chinned Laughing Thrush	*Garrulax rufogualris occidentalis*
215.	Streaked Laughing Thrush	*Garrulax lineatus*
216.	Black-caped Sibia	*Heterophasia capistrata*
217.	Spotted Flycatcher	*Muscicapa striata sarudnyi*
218.	Kashmir Sooty Flycatcher	*Muscicapa sibirica gulmeri*
219.	Rufous-tailed Flycatcher	*Muscicapa ruficauda*
220.	Red-breasted Flycatcher	*Muscicapa parva*
221.	Rufous-breasted Flycatcher	*Muscicapa hyperythra*

222.	White-browed Blue Flycatcher	*Muscicapa supercillaris supercillaris*
223.	Western Slaty Blue Flycatcher	*Muscicapa leucomelanura leucomelanura*
224.	Rufous-bellied Niltava	*Muscicapa sundara*
225.	Blue-throated Flycatcher	*Muscicapa rubeculoides rubeculoides*
226.	Verditer Flycatcher	*Muscicapa thalassina thalasinna*
227.	Red-breasted Kashmir Flycatcher	*Ficedula subrubra*
228.	Shimla Grey-headed Flycatcher	*Culcicapa ceylonensis calcochrysea*
229.	Himalayan Paradise Flycatcher	*Terpsiphone paradisi leucogaster*
230.	Kashmir Strong-footed Bush Warbler	*Cettia montana pallida*
231.	Rufous-capped Bush Warbler	*Cettia brunnifrons whistleri*
232.	Large-billed Bush Warbler	*Bradypterus major major*
233.	Nepal Brown Hill Warbler	*Prinia criniger criniger*
234.	India Great Reed Warbler	*Acrocephalus stentoreus brunnescens*
235.	Blyth's Reed Warbler	*Acrocephalus dumetorum*
236.	Paddy-field Warbler	*Acrocephalus agrocola*
237.	Witherby's Paddy-field Warbler	*Acrocephalus concinens horingtoni*
238.	Sedge Warbler	*Acrocephalus melanopogan*
239.	Barred Warbler	*Sylvia nisoria*
240.	Garden Warbler	*Sylvia borin*
241.	Blyth's Lesser Whitethroat	*Sylvia curruca blythi*
242.	Hume's Lesser White-throat	*Sylvia curruca athaea*
243.	Sind Chiffchat	*Phylloscopus collybita sindianus*
244.	Plain Leaf Warbler	*Phylloscopus neglectus*
245.	Tytler's Leaf Warbler	*Phylloscopus tytleri*
246.	Tickell's Leaf Warbler	*Phylloscopus affinis*
247.	Olivaccous Leaf Warbler	*Phylloscopus grisesolus*
248.	Hume's Yellow-browed Leaf Warbler	
249.	Ticehurst's Leaf Warbler	*Phylloscopus prorgulus simlaenis*
250.	Long-billed Leaf Warbler	*Phylloscopus magnirostris*
251.	Dusky or Greenish Leaf Warbler	*Phylloscopus trochiloides ludowi*
252.	Large-crowned Leaf Warvler	*Phyllocopus occipitalis occiptalis*
253.	Kashmir Grey-headed Flycatcher-warbler	*Seicercus xanthoschistos albosuperciliaris*
254.	Himalayan Goldcrest	*Regulus regulus himalayensis*
255.	Stoliczks's Tit Warbler	*Leptopoecile sophiae sophiae*
256.	Ladkah Bluethroat	*Erithacus svecicus abboti*
257.	West Himalayan Rubythroat	*Erithacus pectoralis pectoralis*
258.	Indian Blue Chat	*Eritahus brunneus brunneus*
259.	Kashmir Red-flanked Bush Robin	*Eritahus cyanurus palliditor*
260.	Eversmann's Redstart	*Phoenicurus erythronotus*
261.	Blue-headed Redstart	*Phoenicurus caeruleocephalus*

262.	Kashmir Redstart	*Phoenicurus ochruros phoenicuroides*
263.	White fronted or Eurasian Redstart	*Phoenicurus phoenicurus phoenicurus*
264.	Blue-fronted Redstart	*Phocaricurus frontalis*
265.	Goldstad's Redstart	*Phoenicurus erythrogaster grandis*
266.	Plumbeosus Redstart	*Rhyacornis fuliginosus*
267.	Hodgson's Shortwing	*Hodgsonius phoenicuroides*
268.	Little Forktail	*Enicurus scouleri scouleri*
269.	Spotted Forktail	*Enicurus maculatus maculatus*
270.	Indian Stone Chat	*Saxicola torquata maura*
271.	Northern Indian Pied Bush Chat	*Saxicola caprata bicolor*
272.	Isabelline Wheatear	*Oenanthe isabellina*
273.	Desert Wheatear	*Oenanthe deserti oreophila*
274.	Variable Wheatear	*Oenanthe picata*
275.	Pleschanka's Wheatear	*Oenanthe pleschanka pleachanka*
276.	White-capped Riverchat	*Chaimarrnornis leucocephalus*
277.	Brown-backed Indian Robin	*Saxicoloides fulicata cabaiensis*
278.	Blue Rock Thrush	*Monticola saxatilis*
279.	Blue-headed Rock Thrush	*Monticola cinclorhynchus*
280.	Indian Blue Rock Thrush	*Monticola solitarius pandoo*
281.	Blue Whistling Thrush	*Myiophonus caeruleus temminickii*
282.	Tickell's Thrush	*Turdus unicolor*
283.	Central Asian Blackbird	*Turdus merula maximus*
284.	Grey-headed Thrush	*Turdus rubrocanus rubrocanus*
285.	Black-throated Thrush	*Turdus ruficollis atrogularis*
286.	Dusky Thrush	*Turdus naumanni eunomus*
287.	Song Thrush	*Turdus philmelos*
288.	Mistle Thrush	*Turdus viscivorus bonapartei*
289.	Kashmir Wren	*Troglodytes troglodetes neglectus*
290.	Kashmir White-breasted Dipper	*Cinculus cinculus cashmirensis*
291.	Indian Brown Dipper	*Cinculus pallasi tenurostris*
292.	Turkestan Alpine Accentor	*Prunella Collaris rufilata*
293.	Garhwal Alpine Accentor	*Prunella collaris whymperi*
294.	Robin Accentor	*Prunella rubeculoides*
295.	Brook's Rufous-breasted Accentor	*Prunella strophiata jerdoni*
296.	Brown Accentor	*Prunella fulvescens fulvescens*
297.	Black-throated Accentor	*Prunella atrogularis*
298.	Kashmir Grey Tit	*Parus major cashmerensis*
299.	Shimla Green-backed Tit	*Parus monticolus monticolus*
300.	Crested Black Tit	*Parus melanolophus*
301.	Rufous-naped Tit	*Parus fugonuchalis*
302.	Fire-capped Tit	*Cehphalopyrus flammiceps flammiceps*
303.	Red-headed Tit	*Aegithalos concinnus iredalei*
304.	White-throated Tit	*Aegithalos nivegularis*
305.	Common Nuthatch	*Sitta europaa cashmirensis*
306.	White-cheeked Nuthatch	*Sitta leucopsis leucopsis*

307.	Wall Creeper	*Tichodroma muraria*
308.	Hodgson's Tree-creeper	*Certhia familiaris hodgsoni*
309.	Himalayan Tree-creeper	*Certhia himalayana limes*
310.	Ladakh Tree-creeper	*Certhia himalayana taeniura*
311.	Indian Tree Pipit	*Anthus hodgsonii*
312.	Witherby's Tree Pipit	*Anthus trivialis haringtoni*
313.	Paddyfield Pipit	*Anthus novaeseelandiae*
314.	Red-throated Pipit	*Anthus cervinus*
315.	Vinaceous-breasted Pipit	*Anthus roseatus*
316.	Brown Rock Pipit	*Anthus similis jerdoni*
317.	Water Pipit	*Anthus spinoletta coutellii*
318.	Upland Pipit	*Anthus sylvanus*
319.	Yellow Wagtail	*Motacilla flava beema*
320.	Hodgson's Yellow-headed Wagtail	*Motacilla citreola calcarata*
321.	Grey Wagtail	*Motacilla cinerea cinerea*
322.	Hodgson's Pied Wagtail	*Motacilla alba alboides*
323.	Forest Wagtail	*Motacilla indica*
324.	Purple Sunbird	*Nectarinia asiatica*
325.	Western White Eye	*Zesterops pa*
326.	House Sparrow	*Passer domesticus*
327.	Spanish Sparrow	*Passer hispaniolensis*
328.	Kashmir Cinnamon Sparrow	*Passer rutilans debilis*
329.	Tibet Snowfinch	*Montifringilla adamsi adamsi*
330.	Blandford's Snowfinch	*Montifringilla blanfordi blanfordi*
331.	Black and Yellow Grosbeak	*Coccothraustes icterioides*
332.	Allied Grosbeak	*Coccothraustes affinis*
333.	Spot-winged Grosbeak	*Coccothraustes melanozanthos*
334.	Himalayan Green-finch	*Carduelis spinoides spinoides*
335.	Himalayan Gold-finch	*Carduelis carduelis caniceps*
336.	Linnet	*Acanthis cannabina belia*
337.	Western Twite	*Acanthis flavirostris montanella*
338.	Eastern Twite	*Acanthis flavirostris rufostrigata*
339.	Gold-fronted Finch	*Serinus pusillus*
340.	Hodgson's Mountain Finch	*Leucosticte nemoricola altaica*
341.	Brandt's Mountain Finch	*Leucosticte brandti brandti*
342.	Severtzow Mountain Finch	*Leucosticte brandi pamirensis*
343.	Gould's Mountain Finch	*Leucosticte brandi haemetopygia*
344.	Western Yellow-billed Blue Magpie	*Cissa flavirostris cucullata*
345.	Common Rose-finch	*Carpodacus erythrinus roseatus*
346.	Pink-browed Rose-finch	*Carpodacus rhodochrous*
347.	Red-mantled Rose-finch	*Carpodacus rhodochlamys*
348.	Kashmir White-browed Rose-finch	*Carpodacus thura blythii*
349.	Great Rose-finch	*Carpodacus rubicilla severtzovi*
350.	Eastern Rose-finch	*Carpodacus rubicilloides lucifer*

351.	Vaurie's Red-breasted Rose-finch	*Carpodacus puniceus kilianensis*
352.	Sharpe's Red-breasted Rose-finch	*Carpodacus puniceus humii*
353.	Red-browed Finch	*Callacanthis burtoni*
354.	Orange Bull-finch	*Pyrrhula aurantiaca*
355.	Pine Bunting	*Emberiza leucocephalos*
356.	White-capped Bunting	*Emberiza steawarti*
357.	Wood-pecker	*Picoides auriceps auriceps*

Appendix 3
Reptiles of J&K State

S. No.	Common Name	Scientific Name
1.	Indian Mud or Flapshell Turtle	*Lissemys punctata punctat*
2.	Narrow-headed Softshell Turtle	*Chitra indica*
3.	Ganges Softshell	*Trionyx gangeticus*
4.	Peacock Softshell	*Trionyx hurum*
5.	Chapant or Smith's Terrapin	*Kachuga smithi*
6.	Spotted or Black Pond Turtle	*Geoclemys hamiltoni*
7.	Annandale's Banded Geeko	*Cyrtodactylus montium salsorum*
8.	Heydon's Banded Gecko	*Cyrtodactylus scaber*
9.	Chiltan Banded Gecko	*Cyrtrodactylus chiltralensis*
10.	Steindachner's Banded Gecko	*Cyrtodactylus stoliczkai*
11.	Stoliczka's Banded Gecko	*Cyrtodactylus lawaderanus*
12.	Banded Gecko	*Cyrtodactylus species*
13.	Brook's Gecko	*Hemidactylus brooki*
14.	Northern House Gecko	*Hemidactylus flaviviridis*
15.	Fna-throated Lizard	*Sitana ponticeriana*
16.	Gilding Gecko	*Eublepharis macularius*
17.	Himalayan Agama	*Agama himalayana himalayana*
18.	Kashmir Agama	*Agama tuberculata*
19.	Stoliczka's Agama	*Agama agrorensis*
20.	Common Garden Lizard of Bloodsuker	*Calotes vericolor*
21.	Blyth's Toad Agama	*Phrynocephalus theobaldi*
22.	Toad Agama	*Phrynocephalus reticulatus*
23.	Hallowell's Skink	*Mabuya dissimilis*
24.	Himalayan Skink	*Leiolopisma himalayaum*
25.	Blyth's Skink	*Eumeces taeniolatus*
26.	Jerdon's Snake-eye	*Ophisops jerdoni*
27.	Common Indian Monitor	*Varanus bengalensis*
28.	Indian Python	*Python molursus molursus*
29.	Russell's Earth Boa	*Eryx conicus*
30.	John's Earth Boa	*Eryx johni johni*
31.	Gary's Ratsnake	*Coluber ventromaculatus*
32.	Brown Diadem Snake	*Coluber diadema diadema*
33.	Pinke Diadem Snake	*Coluber diadema atriceps*
34.	Dhaman or Rat Snake	*Ptyas mucosus*
35.	Common Kukri Snake	*Oligodon arnensis*
36.	Common Indian Bronzeback Snake	*Dendrelahis tristis*
37.	Common Wolf Snake	*Lycodon aulicus*
38.	Travancore Wolf Snake	*Lycodon travancoricus*
39.	Shaw's Wolf Snake	*Lycodon striatus*
40.	Buff -striped Keelback Snake	*Amphiesma stolata*
41.	Checkered Keelback	*Xenochrophis piscator*
42.	Trinket Snake	*Elaphe helena*

43.	Gunther's Sandsnake	*Psammophis leithi*
44.	Forskal's Sandsnake	*Psammophis schokari*
45.	Blyth's Cat Snake	*Boiga multifasciata*
46.	Indian Gamma or Cat Snake	*Boiga trigonata*
47.	Common Indian Krait	*Bungurus caeruleus*
48.	King Cobra	*Naja naja naja*
49.	Central Asian Cobra	*Naja naja oxiana*
50.	Russell's Viper	*Vipera ruselli ruselli*
51.	Levantine Viper	*Vipera lebetina*
52.	Saw Scaled Viper	*Echis carinatus*
53.	Himalayan Pit Viper	*Aneistrodon himalayanus*

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