CHAPTER 1 : INTRODUCTION

1.1 THE PREAMBLE

The high altitude landscape comprising varied ecosystems - sub-tropical, temperate and sub-alpine forests and alpine pastures in the Himalayan region harbours rich biodiversity and represents one of the most important, fragile and threatened life support system on the earth. The Himalayan mountain ranges representing two prominent Indian biogeographic zones *viz*., the Trans-Himalaya and the Himalayas, together occupy nearly 10.9% of the country's total land surface (Rodgers and Panwar, 1988). However, their values in terms of natural resources is much greater than the area implies. The most important resource is water. Nearly one third of the country's population in the Indo-Gangetic Plains are totally dependent on the Himalayan rivers for drinking, irrigation, electricity and industry. Moreover, since time immemorial local people have used forests and pastures throughout the Himalayan region for multiple uses and values. Among these, prominent ones are collection of herbs and medicinal plants, fuelwood and fodder, agriculture and livestock grazing. Pastoralists migrate from lower reaches to alpine pastures every summer along with large herds of sheep and goat. Indeed, traditionally the livestock rearing in the region has been the backbone of local economy. However, in recent years it has been felt that traditional land use practices and ever increasing human demands are probably neither sustainable nor conducive to the long term biodiversity conservation objectives.

1.2 THE MAJOR PROJECT

In order to ensure long term conservation goals, a World Bank aided project on the Conservation of Biodiversity through ecodevelopment approach was undertaken by the Himachal Pradesh Forest Department (HPFD) in the Great Himalayan National Park Conservation Area (GHNPCA). The project has been designated as the **"Forestry Research Education and Extension Project (FREEP)"**. The FREEP had three main objectives: **(i)** to improve Protected Area (PA) management; **(ii)** to reduce people's dependencies on PAs through village ecodevelopment; and **(iii)** to organise and conduct research, monitoring and education programmes to support PA management. The research and monitoring component under the major project was assigned to the Wildlife Institute of India (WII), Dehra Dun. As a part of the five-year research project, the present study (one of the major tasks) was undertaken which aimed to address different aspects of livestock grazing while integrating this with the overall conservation objectives of GHNPCA.

1.3 THE JUSTIFICATION OF THE PRESENT STUDY

During the last 2-3 decades, several survey studies on the status and floristics of high altitude forests and alpine ecosystems have been undertaken in different regions of the Himalayan biogeographic zone. Likewise, several studies dealing with the inventory, mapping and classification of grazing and forest resources; successional changes, productivity performance, plant-animal interactions, diet selection by grazing animals, nutritional value of preferred plants, habitat use by wild herbivores and socio-economics and mitigation aspects of pastrolism are available. As such the subject of grazing land ecology has been dealt extensively throughout the country. But, the alpine pastures in the North-West Himalaya are probably the least investigated ecosystems. Virtually either very little or scattered information exists on different aspects of livestock grazing and dependent pastrolists. It is not intended here to present an exhaustive review of literature. Most of the past studies either focus on autecology or synecology. Probably none of the studies has tried to integrate different dimensions of livestock grazing and its associated management issues. Realising the traditional dependence of local people on livestock rearing in and around the GHNPCA and its long term implications for the conservation of biodiversity and overall environmental security of the highly fragile ecosystem, the present study was undertaken. This is probably the first attempt wherein an integrated landscape management approach was used for assessing various issues of livestock grazing alongside the biodiversity concerns in the conservation area.

1.4 Biodiversity Concerns and the Landscape Approach

With a temporal shift in thinking, perception and enforcement of recent conservation laws and policies, it is considered appropriate first to briefly dwell upon the various approaches applied world wide for the conservation of biodiversity, before going into details of the present study. The Wildlife (Protection) Act (Anon., 1972); the Forest (Conservation) Act, 1980 (Bagga, 1989); National Forest Policy (GOI, 1988); National Conservation Strategy (Anon., 1992); UNCED Convention on Biological Diversity, 1992; and the initiation of bold and innovative efforts like the Project Tiger, 1973; Planning for Protected Area Network in India (Rodgers and Panwar,1988) focusses on the legal and policy foundations relevant to the environmental security and conservation of biodiversity.

Increasing emphasis on the conservation of biological diversity or biodiversity calls for maintaining variety and variability of life and associated ecological processes. Maintaining biodiversity entails addressing resources at various biological levels *viz.,* genetic, species, population, community, ecosystem and landscape (Marcot, 1989 and 1992; Noss, 1990(a); Hunter, 1991(a) and (b); Williams and Marcot, 1991; Walker, 1992; Salwasser, 1995; Darden and Marcot, 1995; Naveh, 1995; Biodiversity Guidebook, 1995).

There has been a growing awareness among people that healthy, productive and diverse ecosystems are essential for the continued well-being of human societies and to the land itself (Davis, 1989; Salwasser, 1995). Thus, the resource managers, world-over are facing complexities arising, on one hand due to a complete shift in thinking, concepts, and approaches *viz*., timber production to forest conservation, sustained yield to sustainability of ecosystems, single species management to the conservation of biodiversity, etc. while on other hand fast-shrinking forests, excessive grazed grazing lands, and further aggravating human demands on these resources lead to conflicts. A network of biogeographically representative protected areas (PAs) has been recognised as a means of conservation.

1.4.1 Protected Area Management - Challenges

A network of protected areas (PAs) comprising National Parks (NPs) and Wildlife Sanctuaries (WLS) has been established in India (Rodgers and Panwar, 1988). Although the Wildlife (Protection) Act, 1972 prohibits human settlements, cattle camps, and livestock grazing inside the NPs and allows only regulated grazing even in the case of WLS after its second time amendment in 1991, in practice this is not the ground reality in several of the PAs (Mathur, 1991). Kothari *et al.* (1989) in their review on the management of Indian PAs have reported that about 80% of the PAs have cattle grazing, about 25% of them have more than 50 head of cattle per sq km apart from goats.

Except a few sporadic successful relocation schemes of shifting village settlements from the NPs, desired level of success has not been achieved due to conflicting socio-economic-political considerations. For the want of such relocations and extinguish of rights and concessions, several NPs still await their final legal notification. As remarked by Brown (1971) and stated by Mathur (1991), Kothari *et al.* (1989), the most serious threat faced by Indian wildlife or PAs is not so much by poaching as by the irreversible destruction of habitat is being induced by man either directly or indirectly through his domestic animals.

The resource managers, particularly foresters are 'expected to address three timeless forestry goals *viz.,* **(i)** ensure environmental security by protecting soil, water, air and biological diversity; **(ii)** meet the basic needs of the people who depend on them for food, fuel, shelter, livelihood and recreation, and unity with nature; and **(iii)** contribute to short and long term social and economic development.

1.4.2 Biodiversity Conservation - Prospects

In spite of above described complexities and challenges faced by resource managers, ample opportunities and directions have been highlighted in the recent literature for managing different ecosystems for multiple values and uses. Several new tools and approaches those have been described

in this regard are: flagship and umbrella species management (Marcot, 1989 and 1991; Hunter, 1991(a); coarse and fine filter approach (Hunter, 1991(b); and Biodiversity Guidebook, 1995); watershed management (Kunkle, 1986; Franklin, 1992); multiple purpose silviculture (Benskin and Bedford, 1995; Brand and LeClaire, 1994); sustainable forest management (Lanly, 1995); integrated resource or environmental management, (Hunter, 1991(a); Teer, 1991; Marcot, 1992; Salwasser, 1991, 1994, and 1995); holistic landscape conservation - Williams and Marcot, 1991; Naveh and Lieberman; 1993, and Naveh 1995; Karr, 1992 and 1994; Lucas, 1992; Risser *et al.* 1984; Noss, 1983, 1987, and 1990 (a) and (b).

Most of the above stated approaches are of recent origin, they largely provide insight but lack in details of field implementation and appropriate examples of successful case studies. Some of the above concepts and strategies are briefly highlighted below:

(i) Initially the term biological diversity or biodiversity meant different things to different people (Noss, 1990 b). Now with the advent of growing knowledge biodiversity is seen as an environmental end point. It is amply clear that biodiversity is a variety and variability of all life forms along with associated ecological processes and therefore includes all domestic, cultivated and wild plants and animals.

(ii) Biodiversity concerns can be better dealt holistically, rather than in the traditional and fragmentary species-by-species manner by just management of rare and endangered, keystone, indicator species or some guilds. The intent is to maintain in perpetuity all native species of plants and animals across their historic ranges.

(iii) Management of biodiversity is relevant to landscape regardless of administrative boundaries. Landscape units (a watershed or series of similar and interacting watersheds) are the basis on which the success of biodiversity management can be evaluated.

(iv) The conservation of biodiversity depends on a co-ordinated strategy, effective communication and joint participation by all concerned.

(v) Where past forest management practices or other biotic influences have resulted in degraded forest or grazing land situations, biodiversity can be restored to some extent over time by managing the land to create - or recover - the required ecosystem elements.

1.5 THE MAIN AIM

In the above context, the present study was undertaken in the Great Himalayan National Park Conservation Area (GHNPCA) and its surrounds with an aim to assess various issues of livestock grazing on a regional landscape basis and to suggest a long term strategy for integrating sustainable grazing compatible to biodiversity objectives.

1.6 THE HYPOTHESES

The study aimed to address some common pertinent questions *viz*.,

- Is the current level of livestock grazing in the study area compatible with the long term conservation objectives?
- Can livestock grazing co-exist with other sympatric wild species?, and
- How best the diversity and productivity of forests and alpine pastures can be maintained in future along side sustainable livestock grazing?

1.7 THE OBJECTIVES

In order to achieve requirements of the above stated aim and answer the hypotheses posed, the following objectives were set forth:

(a) To make inventories of grazing resources and dependent livestock in the study area.

(b) To classify, assess and determine utilisation pattern of available grazing resources, and provide information on their conservation status.

(c) To develop an understanding of ecological relationships with greater emphasis on alpine pastures.

(d) To suggest a long term monitoring programme for recording changes resulting due to livestock grazing.

(e) To provide management prescriptions both at the landscape and site specific level for sustainable livestock grazing in the area.

1.8 ORGANISATION OF THE REPORT

This report contains Six Chapters. The Chapter 1 deals with the general introduction highlighting the concerns arising due to livestock grazing in the fragile high altitude Himalayan landscape *vis*-a-*vis* biodiversity conservation, the major research project, rationale of the study, the main aim, hypotheses posed and the objectives set-forth. The Chapter 2 describes the study area and various approaches adopted to achieve the objectives of the present study. The Chapter 3 profiles the landscape, its environment and also presents an assessment on the distribution, types and extent of grazing resources. This Chapter highlights the physical, biological and socio-economic environments of the landscape and attempts to establish linkages with different aspects of livestock grazing in the study area. The Chapter 4 describes the structure and composition of various grazing and fodder resources, assess the current biotic pressures on these resources, and also determine their overall conservation status. The Chapter 5 examines the grazing practices and determines socio-economics of the graziers. The Chapter 6 discusses the present study adopting a holistic approach to evaluate biological, sociological and conservation implications of current livestock grazing practices *vis-à-vis* with the changing scenario, policies, law and consequent life styles. This Chapter concludes the study by presenting specific recommendations for the site as well as landscape level management approaches while emphasizing future research and integral monitoring needs. The Chapter 6 is followed by a list of references.

CHAPTER 2 : THE STUDY AREA AND APPROACH

2.1 THE STUDY SITE

The present study was carried out in the Great Himalayan National Park (GHNP) and its surrounds. Hereafter, called as the GHNP Conservation Area (GHNPCA). The area is situated between latitude 31°33'00" and 31°56'56" North and longitude 77°17'15" to 77°52'05" East. The study area comes under the biogeographical zone - 2A North-West Himalayas (Rodgers and Panwar, 1988). Administratively, the Great Himalayan National Park lies in Kullu District of Himachal Pradesh and is located on the junction of two great faunal realms: Palaearctic to the north and Oriental to the south (Mackinon *et al*. 1986). The conservation area makes catchment of Tirthan, Sainj, Jiwa and Parvati rivers which together forms the upper catchment of one of the major perennial rivers in the region i.e. river 'Beas'. Much of the eastern part of the GHNPCA is perpetually snow bound or under snow (Sharma, 1987). The human population exists only on the western and the north western boundary of the park, the other area are demarcated by high ridges and peaks. The GHNPCA is having three constituent PAs *i.e.* GHNP and two Sanctuaries (Tirthan and Sainj), these were declared by two subsequent gazette notification(s) in the year 1984 and 1994, respectively (IIPA, 1995).

The GHNP area is free from village settlements, except it continued to have old rights and concessions mainly related to the right of way, collection/harvest of various forest produces and use of alpine pastures for livestock grazing until the recent past. The final notification of GHNP was long due for the want of settlement of these rights and concessions granted to local people earlier (Anderson, 1886). It was however, by the intervention and specific directives issued by the Supreme Court of India as a result of the Public Interest Litigation (PIL) praying for the effective conservation of protected areas in the country by ensuring early enforcement of legal provisions made under the Wildlife (Protection) Act, 1972 that the process of settlement in the case of GHNP was accelerated. At last, the Government of Himachal Pradesh issued the final notification no. FFE – B – F (3) – 2/99 dated 28 May, 1999 for GHNP. This sudden process of settlement and issue of the final notification after a long gap from the date of initial notification in the year 1984 has resulted primarily into: (i) the abrupt acquisition of traditional rights and concessions (specifically collection of medicinal herbs and livestock grazing) to local people by paying compensation; and (ii) slight alterations in the legal boundaries and area statistics of GHNPCA. Since the present study was carried out during 1995-1998 prior to the final notification, the collection and analysis of field data was already completed prior to the recent development. It was only at the time of final writing/synthesis of this report that the local situation pertaining to the livestock grazing in GHNPCA has altered and thus, called for a second look to the grazing problem in the changed scenario and its implications for conservation and pastoralism as such. In view of the above stated position, the

presentation of results, graphics and discussion are mainly based on the pre-revised status. However, likely implications of recent development have been appropriately looked into while describing specific recommendations for the management.

The GHNPCA covers an area of 1,171 sq km and its four constituents (**Fig 2.1**) are: (i) the Great Himalayan National Park (GHNP), (ii) Sainj Wildlife Sanctuary (Sainj WLS), (iii) Tirthan Wildlife Sanctuary (Tirthan WLS), and (iv) Ecodevelopment Zone (EZ). A comparative account of the area statistics for the constituent PAs and EZ prior to and after the recent legal changes is presented below in **Table 2.1**.

Table 2.1 - Area Statistics for the GHNPCA

Sl. No.	Category	Pre-revised Area (sq km)	Revised Area (sq km)
1	Great Himalayan National Park (GHNP)	765.0	754.4
2	Tirthan Wildlife Sanctuary (Tirthan WLS)	61.0	61.0
3	Sainj Wildlife Sanctuary (Sainj WLS)	90.0	90.0
4	Ecodevelopment Zone (EZ)	255.0	265.6
Total Area		**1,171.0**	**1,171.0**

The **Table 2.1** indicates that as such the total area of GHNPCA remained unaltered. However, there was a slight area adjustment of 10.6 sq km between the GHNP and EZ. Details of the geographical boundaries of GHNPCA have been described by Negi (1996).

The Sainj WLS has two villages, namely Shakti and Maror. The Ecodevelopment Zone on the western periphery within a radial distance of 5 km from GHNP has 13 villages ('Phanti' - cluster of hamlets). The major pressure on the GHNP and two WLS comes from these villages. The local residents still claim traditional rights for grazing and collection of medicinal plants in spite recent issue of the final notification. A large part of the GHNPCA lies in `Waziri Inner Seraj' (sub-block) of `Seraj/Banjar Tehsil' (Block), while a small portion falls in sub-block `Waziri Rupi' of Kullu Tehsil (**Fig. 2.2**). The GHNPCA besides supporting livestock residing within the Sainj Sanctuary and the Ecodevelopment Zone has also been receiving pastrolists and grazing sheep and goat herds from the adjacent cluster of villages in Ani Tehsil. The GHNPCA forms a large contiguous PA network with the Pin Valley National Park in the east; Rupibhabha Wildlife Sanctuary in the south-east; Khirganga protected forest and Kanawar Wildlife Sanctuary in the north-west. Thus, the GHNPCA becomes an area of high conservation significance in the region (**Fig. 2.1**).

The highly varied topography, physiography and past management of the landscape has resulted in diverse ecosystems and floral and faunal species. Since the following Chapter specifically focuses on the landscape and its environment, the physical, biological and socio-economic environments of the study area are dealt in greater detail therein.

2.2 THE RECONNAISSANCE

As already stated, the present study was a part of the major FREEP–GHNP Research Project and was initiated after obtaining requisite permission from the Director, GHNP, Kullu for carrying out research work in the GHNPCA. A rapid survey in representative field areas across GHNPCA was undertaken during July-December, 1995. On the basis of reconnaissance, the present study was designed in February , 1996 (Mehra and Mathur, 1996).

2.3 THE HIERARCHICAL AND LANDSCAPE APPROACH

The hierarchical theory suggests that higher level of organisation incorporates and contains the behaviour of lower level (O'Neill *et al.*, 1986; Noss, 1990b). The importance of higher order constraints does not suggest that monitoring and assessment be limited to higher level only (e.g. remote sensing of landscape structure). Lower level in a hierarchy contains the details as species identities and abundance. The hierarchy concept suggests that biodiversity be monitored at multiple levels of organisation, and at multiple spatial and temporal scales. No single level of organisation (e.g. species, population, community) is fundamental and different levels of resolution are appropriate for different questions.

The above hierarchical and landscape approach would thus entail a conceptual framework for identifying species, measurable indicators to monitor and assess the overall status of biodiversity at multiple levels in relation to livestock grazing. The entire study area has been thus, recognised as one large landscape consisting of four sub-watersheds (SWS), namely Tirthan, Sainj, Jiwa and Parvati (**Fig.2.3**).

In order to integrate and make an overall assessment of various aspects of livestock grazing in the GHNPCA, a combination of traditional field assessments and modern techniques *viz.,* application of remote sensing and Geographical Information System (GIS) was used. Among traditional techniques, use of secondary information, questionnaires, interviews (villagers, pastrolists and PA officials), field estimates, inventories and ground quantification of various habitat variables were carried out. The present study thus, focuses on a combined strategy of an extensive study at the landscape level while intensive study at specific identified sites.

The methodology adopted for the following three Chapters on specific themes is described below:

2.4 THE METHODOLOGY

2.4.1 The Landscape, its Environment and Livestock Grazing

The concepts, principles and approaches related to the Landscape Ecology and Dynamics are increasingly used world wide to address complex conservation issues and management of natural resources. This becomes more pertinent in the case of highly undulating and fragile Himalayan landscape wherein the livestock, wild animals and human use different landscape components/units across the altitudinal gradient or watersheds during various seasons. Likewise, different slope categories and aspects also play an important role in influencing the floral and faunal diversity and their use patterns. Recognising the merit of these facts, it was considered essential to describe, characterise and assess the landscape and its environs as a first step towards addressing the complex issue of livestock grazing.

2.4.1.1 The Landscape Level Mapping

The entire GHNPCA was treated as one landscape constituting the catchments of the river Beas and comprising four sub-watersheds (SWS) *viz*., Tirthan, Sainj, Jiwa and Parvati. The Survey of India (SOI) toposheets no. 53 E/5; 53 E/6; 53 E/9; 53 E/10; 53 E/13; and 53 E/14 at 1:50,000 scale and management maps obtained from the park management, HPFD were mainly used as reference maps. The Indian Remote Sensing (IRS) IB LISS II data, Geocoded false colour composites (FCC) with the standard band combination (band 2, 3 and 4) at 1:50,000 scale with a resolution of 36.25 m for the period: September-October, 1993 obtained from the National Remote Sensing Agency (NRSA), Hyderabad was used for the landscape level mapping, assessment and characterisation. A preliminary field survey was undertaken in Sainj SWS during May-June, 1996 to correlate the image characteristics and ground features using standard visual interpretation techniques (Anon., 1983). An interpretation key based on the image properties and ground feature relationship was developed for FREEP–GHNP Research Project by Naithani and Mathur (1998). The image elements usually considered for interpretation *viz*., tone, size, slope, shadow association and physiography were taken into account (Tomar, 1998). The interpretated key was modified (**Table 2.2**) keeping in view the objectives of the present study. Subsequently, during the field study, the desired ground validation work was undertaken in pre-determined and representative sites. The interpretation key and field knowledge were used to prepare the landuse/ forest cover map highlighting different grazing resources. A diagrammatic presentation of the visual interpretation process is given in **Fig 2.4**.

Additional information on the drainage and topography (contours at 120 m interval) were also digitised based on the SOI toposheets in the Geographical Information System (GIS) domain using ARC/INFO package to generate desired maps and better understanding of the landscape features in relation to livestock grazing.

Table 2.2 A - Interpretation Key for Land Use and Forest Cover Mapping in GHNPCA Using IIRSLISS II Data Band Combination 4 3 2, on 1: 50,000 Scale (Source: Naithani and Mathur, 1998)

Sl No	Tone	Texture	Physiography	Elevation (Gaston and Garson, 1992)	Type	Vegetation Association
1	Bright red	Medium to Coarse	Moderate to steep slope of hill	600-1700m.	Sub tropical pine forest, mainly chir pine	Conifer, Chirpine- *Pinus roxburghii*
2	Brownish red to dark brown	Medium to Coarse	The study area and all aspect with varying density till the beginning of sub-alpine	1500-3300m.	Himalayan moist temperate forest	Mixed conifer, *Pinus wallichiana, Abies pindrow, Picea smithiana, Cedrus deodara*
3	Red to brownish red to bright red with whitish ting	Medium to Coarse	Gentle to medium slopes with thick soil cover in all study area and nalas	1500-3300m.	Himalayan moist temperate forest	Conifer and broad leaved - *Pinus wallichiana, Abies pindrow, Q.leucotrichophora, Q.loribunda, Acer sp., Aesculus indiaca, Prunus cornuta*
4	Various shades of red to brownish red	Medium to Coarse	Gentle to medium slopes and spurs on the ridges, soil cover sufficient	1500-3300m.	Himalayan moist temperate forest	Broad leaved and conifers- Upper story : *Q.semecarpifolia*, B*etula utilis*, *Abies pindrow*, *Taxus, Prunus* cornuta, *Acer sp.* Under story- *Viburnum, Lonicera, Rosa, Sinaruindinaria sp.*
5	Bright red to deep red	Medium to Coarse	Along gentle to medium slopes, moist areas, along nalas and village surroundings	1500-3300m.	Himalayan moist temperate forest	Broad leaved Upper story- *Q. floribunda, Aesculus indica, Q. leuchotrichophora, Betula alnoides, Q. semecarpifolia, Prunus sp.* Under story- *Rhododendron campanulatum, Bamboo brakes, Viburnum, Berberis sp., Indigofera, Rosa, Sorbaria sp.* and grasses.
6	Light red to brownish red	Medium to Coarse	Along river bed only in low elevated areas of park	Upto 2500m.	Lower temperate grass patches	Grass patches *Themada sp., Apluda sp.*

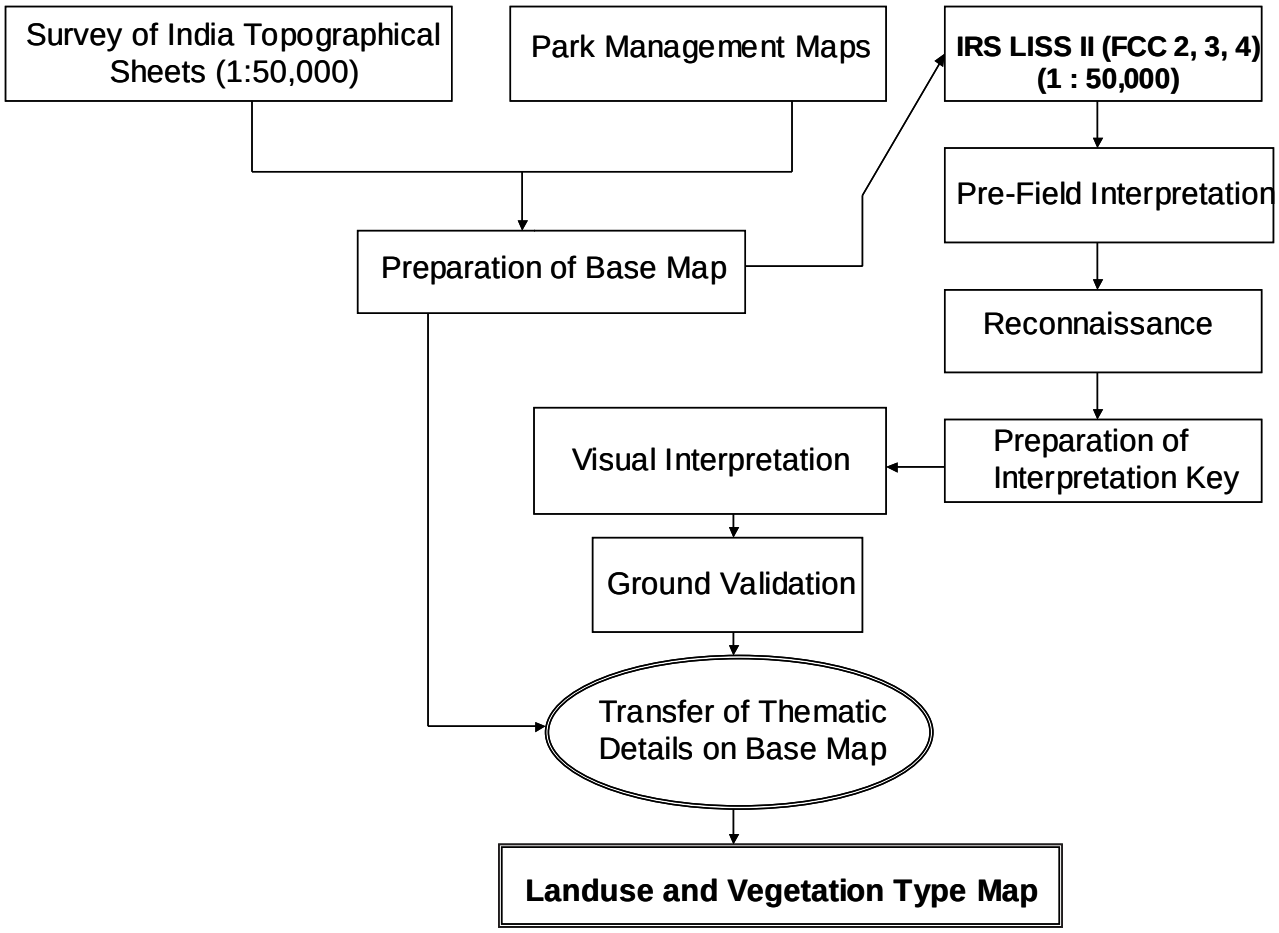
7	Light pink varying shades of grayish and brownish tinge	Medium to Coarse	Higher to medium slopes and around villages also	1500-3300m.	Himalayan moist temperate forest	Secondary scrub *Berberis chitra*, Indigofera, *Rosa sp, Pinus wallichiana, Abies, Acer* and grasses.
8	Pinkish yellow green tinge	Fine to medium	Top of the ridge portions,spurs and moist sloppy areas	Above 3000m to 3600m.	Dry alpine scrub	*Rhododendron campanulatum, Juniper sp., Rhododendron lepidotum, Rhododendron anthopogon* with grasses like *Poa sp. and Danthonia cachemyriana*
9	Light red yellowish and green tinge	Fine to medium	Generally all types of slopes	1500-3600m.	Sub-alpine and alpine grasslands.	*Poa annua, Poa alpina, Agrostis, Danthonia* cachemyriana
10	Various shades of red to brownish red	Medium to Coarse	Medium to higher slopes	1500-3300m.	Temperate zone plantation	Mainly conifer: *Pinus wallichiana*, *Abies,* Broad leaved: *Acer*, and grasses.
11	Varying shades of yellowish green with red tinge	Smooth to fine	Steep to moderate slope	1500-3600m. and above	Temperate, sub-alpine and alpine zone.	Exposed rock, cliff
12	Bluish to cyan colour	Smooth to fine	Steep to moderate and gentle slope	1500-3600m. and above	All study area	Land slides
13	Bright to white and light grey colour	Smooth to fine	Between river channels		Along the rivers	Sand bar
14	Dark blue to dark brown	Smooth to fine	All water bodies of the study area, mostly on higher elevated plains	Between 2000-3000m.	Specially on higher reaches	Water bodies
15	White to dirty white	Smooth to fine	Mostly on gentle to medium slope, specially north and north west aspect	Mostly above 3000m	Above snow line and also depend on slope and aspect	Snow

16	Grey to dirty grey and white	Medium to Coarse	Mostly on medium to higher slopes in upper reaches	Above 3600m.	Below/above snow line and confined within these zones	Morain
17	White	Fine	Mostly on upper reaches	Above 3600m.	Above morrains	Glacier
18	Dirty brown to gray	Medium to coarse	Mostly at middle and margins of morrain	Above 3600m.	After and within morrain	Morainic lands
19	Various tones of red with dark to light gray and pink	Medium to Coarse	Medium to gentle slopes on south as well as south-east aspect	1300 to 2500m.	Mostly on moist temperate zone	Habitation/Orchards/ Agriculture

Table 2.2 B - Modified Key Used for the Present Study Based on Clubbing of Categories

Sl. No.	Landuse/Forest Cover Type	Clubbed categories as of original (a) Key (Sl. No. as of Table 2A)
1	Closed forest	1+2+3+4+5+10
2	Open forest	7
3	Grass Patches	6
4	Dry Alpine Scrub	8
5	Alpine Pastures	9
6	Rocky Slopes/Cliffs	11+12+13
7	Rivers/Lakes	14
8	Permanent snow	15+17
9	Habitation/Agriculture/Orchards	19
10	Moraines	16+18

Fig. 2.4.- Schematic Flow Chart For Visual Interpretation of Satellite Images of GHNPCA

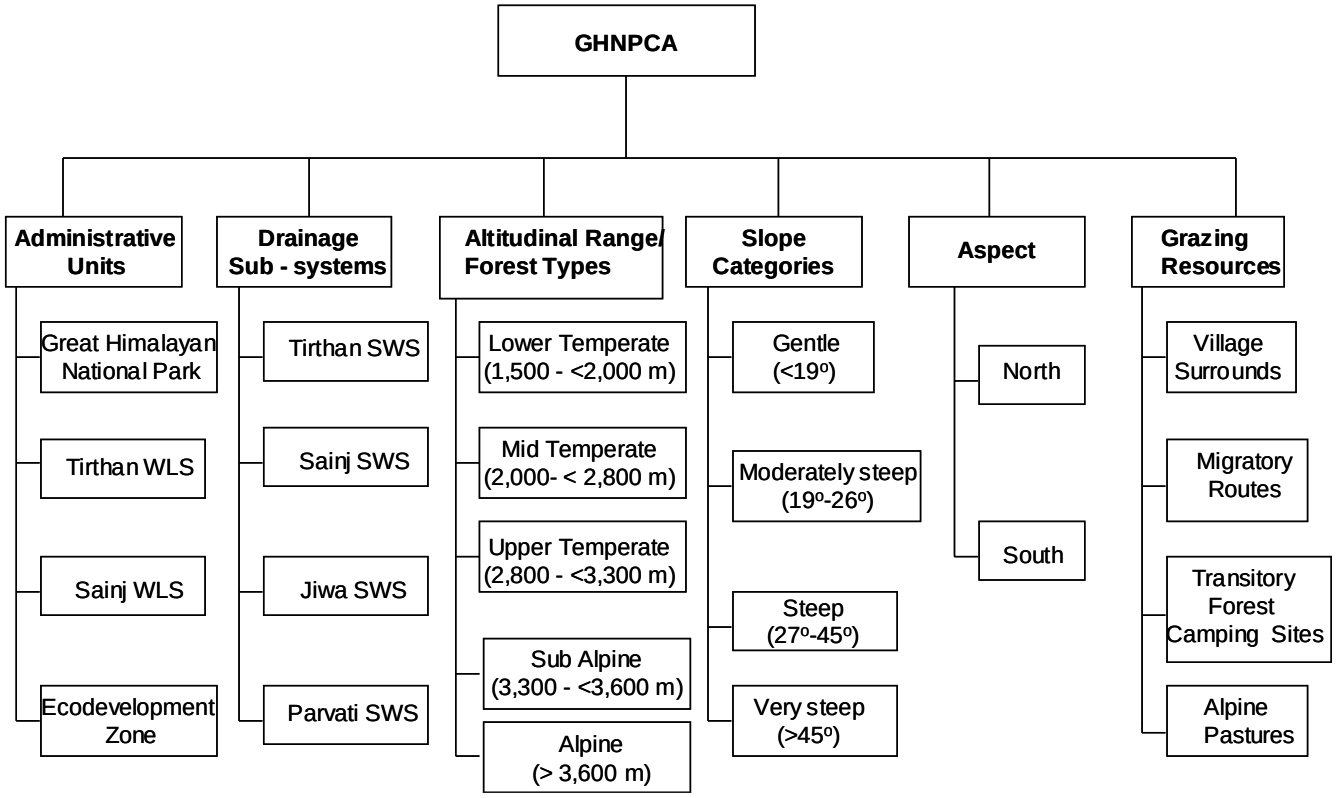


2.4.1.2. The Landscape Characterisation – Its Environment

The knowledge of physical, biological, and socio-economic aspects of the immediate environment facilitates better understanding of ecological interactions and dynamics over time and allows effective planning for the long-term sustainability of the environment and management of its resources (Duffield *et al*. 1998).

Varying administrative/legal units of land, drainage sub - systems, altitudinal range, slope categories, aspect and forest types were considered to be the major controlling factors for diversity and resource use patterns in the study area. Thus, the overall environment is characterised adopting a broad landscape stratification approach using these entities. A diagrammatic presentation of the stratification used for various landscape level assessments and characterisation are given in **Fig. 2.5**. The stratification criteria adopted in the present study is described below:

Fig. 2.5 - Stratification Key for GHNPCA



(a) Administrative Status: The entire GHNPCA is covered under four administrative units *viz*., the Great Himalayan National Park, Tirthan Wildlife Sanctuary, Sainj Wildlife Sanctuary, and Ecodevelopment Zone. These units are governed differently by legal provisions under the Wildlife (Protection) Act, 1972.

(b) Drainage Sub-Systems: The GHNPCA is constituted by four sub-watersheds *viz*., Tirthan, Sainj, Jiwa and Parvati. They vary in the extent, terrain and use pattern. Generally, the resource use is restricted by watershed boundaries.

(c) Slope Categories: Four broad slope categories *viz*., Gentle (<19°), Moderately Steep (19° - 26°), Steep (27° - 45°) and Very Steep (>45°) were used as the varying slope categories directly influence resource use patterns.

(d) Aspect: Two distinct aspects – the north and the south categories were used for the characterisation purpose. The south facing slopes receive more sun light compared to north aspect, resulting into varied structure and composition of vegetation.

(e) Altitudinal Gradient and Forest Types: Five broad forest types corresponding to different altitudinal ranges *viz*., Lower Temperate (1,500 - >2,000 m), Mid Temperate (2,000 - >2,800 m), Upper Temperate (2,800 - >3,300 m), Sub-Alpine (3,300 - >3,600 m) and Alpine (>3,600 m) were recognised and used for different field assessments and characterisation as they experience markedly distinct utilisation pattern by livestock, wild animals and human.

2.4.1.3 The Extent and Distribution of Grazing Resources

The seasonal migration is a traditional way of livestock rearing and management in the region. Thus, livestock and dependent graziers spend winter months in village and village surrounds at lower reaches while they migrate to higher reaches during summer and rainy seasons traversing through various forest/vegetation types. Broadly four types of grazing/fodder resources distinct in their composition, intensity of grazing incidence and seasonal use pattern *viz*., Village pastures ('Ghasnis') and their surrounds (VS), Migratory routes adopted across different forest types and along ascending altitudinal gradient (MR), Transitory forest camping sites (TFCS) and Alpine pastures (AP) were recognised for various assessments at the landscape and site specific levels. Available information through the SOI toposheets, remote sensing data, forest department records, Settlement report (Anderson, 1886), Indicative plan (Mehta *et al.* 1993) field visits and interviews of graziers were used in the identification and mapping of various grazing resources. A list of grazing resources, their extent and distribution according to various stratified categories was an outcome of this component.

2.4.2 Species Diversity, Biotic Pressure and Status of Grazing Resources

Subsequent to the above broad landscape level assessment, the second step focused on field assessments at the site-specific level. Primarily these site-specific assessments aimed to address diversity and use patterns at the species level.

2.4.2.1 The Sampling Strategy

Recognising seasonal area-specific resource use pattern due to various constraints imposed by the terrain and harsh climatic conditions, the sampling strategy for field assessment was appropriately designed. Thus, the summer (April – June) and monsoon or rainy (July – September) seasons were mainly utilized for field data collection in higher reaches i.e. Alpine pastures, Transitory forest camping sites and Migratory routes, while six month long winter (October – March) season was used for data collection in the Village surrounds. These corresponding seasons being the best time for any type of study in above four sites provided optimum conditions for field assessments related to the structure, composition, and utilization of diverse grazing resources. The upper reaches were inaccessible during winter season due to heavy snow. This was the time when plants in Alpine pastures, Transitory forest

camping sites and Migratory routes were covered by snow while livestock concentrated in Village surrounds. At the advent of summer season and melting of snow, plants exhibit their growth phase in higher reaches and majority of plants completed their life cycle before the onset of winter.

In absence of road network in the GHNPCA and rugged terrain, the only means to reach various field sites is tedious and time-consuming tracking. This physical constraint obviously restricts simultaneous visit to various Alpine pastures located in different sub–watersheds. In order to overcome this constraint, it was decided to select the Tirthan SWS as an intensive study area assuming its representativeness to the overall GHNPCA in a larger perspective and also appreciating the fact that: (i) it harbours the maximum number of Alpine pastures; and (ii) it receives maximum number of migratory livestock among four SWS. Further, it is noteworthy to mention here that visit to any Alpine pasture required a minimum tracking of 30-35 km from the last road head. Moreover, inadequate field research infrastructure in terms of camping sites, basic amenities and treacherous trails due to landslides or missing wooden bridges due to floods posed several additional problems in the smooth conduct of field studies. These constraints called for meticulous planning for field visits, particularly accompanying field support – assistants, camping gears, rations, etc. In spite of these explained field odds, as far as possible due care was taken to cover different intensive study sites under any one category of grazing resource in the same season with minimum difference of days.

2.4.2.2 Intensive Study Sites and Field Assessments

Field assessments pertaining to the structure, composition, species diversity and grazing pressure were carried out separately for the four broad categories of grazing resources (VS, MR, TFCS and AP). Details of selected intensive study sites in each category and methods employed for various quantification are provided below (**Fig.2.6**).

Fieldwork was conducted covering an altitudinal range between 1,300-4,800 m. Field identification of flowering plants was done with the help of regional floras, research papers and reports *viz.,* Collect, 1902; Nair, 1977; Rau, 1977; Polunin and Stainton, 1984; and Aswal and Malhotra, 1994; Bohr, 1960; Uniyal *et al.* 1994. Most of the specimens were collected and preserved at the Herbarium of Wildlife Institute of India following Rao and Jain, 1977. Some of the collected specimens were identified by matching specimens already lodged at the Herbaria of Forest Research Institute and Botanical Survey of India, Dehra Dun.

2.4.2.2.1 Village Surrounds (VS)

Out of 127 villages in the Ecodevelopment Zone, six villages and their surrounds were selected as intensive study sites (**Table 2.3**). Three villages *viz*., Ropa, Kharoncha and Nahi in Tirthan SWS and

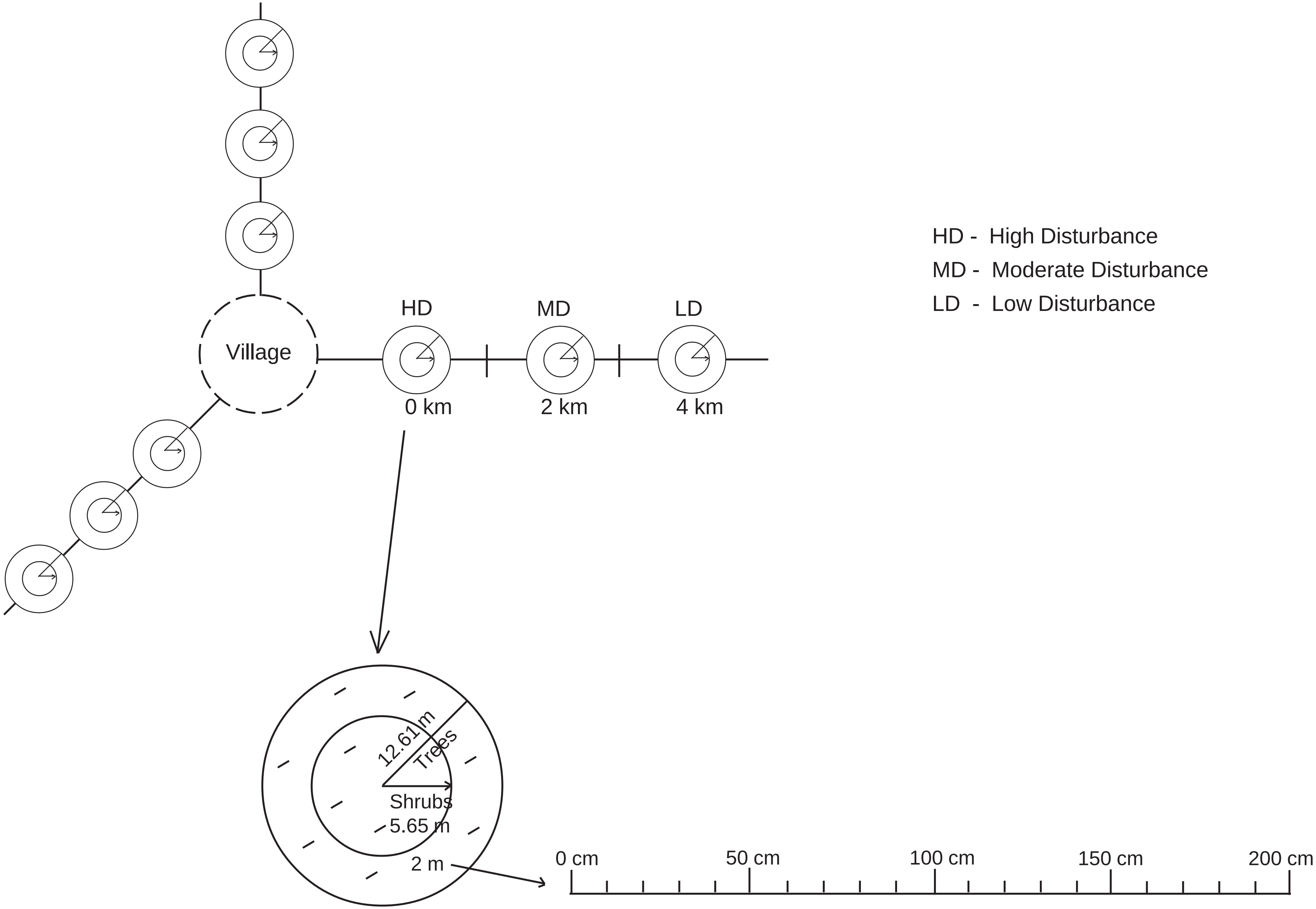
three villages *viz*., Shangarh, Bah and Lapah in Sainj SWS were selected. Among these six villages, four were located on the north aspect whereas Bah and Nahi villages were located on the south aspect. These villages were further classified into three categories of grazing pressure based on the number of resident livestock *viz*., high (>750 livestock), moderate (>300 – 750 livestock) and low (>300 livestock).

Table 2.3 - Intensive Study Sites under the Category of Village Surrounds (VS)

Sl. No.	Village	Sub-watershed	Altitude (m)	Aspect	Grazing Pressure
1	Ropa	Tirthan SWS	1,600	N	Low
2	Kharoncha	Tirthan SWS	1,800	N	High
3	Nahi	Tirthan SWS	1,800	S	Moderate
4	Shangarh	Sainj SWS	2,100	N	High
5	Bah	Sainj SWS	1,800	S	Low
6	Lapah	Sainj SWS	2,200	N	Moderate

Field assessments in selected six village surrounds aimed to assess the diversity of trees, shrubs, and ground cover along biotic pressure in terms of lopped and girdled trees. Field data on regeneration of tree species was also collected. To achieve this, three radiating transects originating from the outskirts of each selected village in the east, north, and south–west directions were laid. In order to have a complete representation of diversity across altitudinal gradient and disturbance regimes, three circular sample plots of 12.61 m radius (500 sq m) at 0 km, 2 km and 4 km distance using nylon rope were laid on each of the radiating transect (**Fig. 2.7**). In each plot, tree species, their individuals and girth at breast height (GBH in cm) were recorded. The individuals of tree species with >20 cm GBH and >3m height with a distinct bole were considered as trees. Observations on lopped, girdled and dead trees by species and their individuals were also recorded. Lower girth classes (<20 cm) of same species were considered as regeneration. A nested plot of 5.65 m radius (100 sq m) was demarcated in the above tree plot for assessing shrub diversity using the same centre. The woody species which had GBH < 20 cm, height < 3m and those branching from base of stem were considered as shrubs (Muller – Dombois and Ellenberg, 1974). The species were identified and their numbers of individuals were recorded. The ground cover estimates were carried out in each tree sample plot using a modified point – intercept method on a line of 2 m. Ten random lines (2m) were laid on the ground in 12.61 m radius plot and ground cover categories (Herb, Grass, Rock/Barren, Dung, Weed and Shrub) were recorded as they hit at every 10 cm interval. In all 20 hit values for ground cover on each of the 10 random lines were recorded. Thus, the data obtained in above manner on trees, shrubs and ground cover composition was used for ascertaining the species richness, species diversity and biotic pressure.

Fig. 2.7 - Diagramatic Representation of Layout of Vegetation Sampling Plots in VS and TFCS



In addition to the above described assessments, two village pastures ('Ghasnis' or hay plots) near village Nahi in Tirthan SWS and village Bah in Sainj SWS, hereafter called as 'Nahi Ghasni' and 'Bah Ghasni', respectively were selected for assessing major constituent grasses and the Above Ground Biomass (AGB) and Below Ground Biomass (BGB) by the Harvest method (Odum, 1960). The vegetation was clipped nearest to the ground in quadrat (25 cm X 25 cm) during September–October, 1997 when grasses have attained maximum height, maturity and ready for harvest by local people for hay purpose. 50 quadrats in each Ghasni were laid. The fresh weight in each case was recorded using a 5-kg field balance. The clipped vegetation was sun–dried and dry weight was recorded until a constant weight was reached. The values of AGB in g/m^2 were calculated. Likewise, 50 monoliths of 25 cm X 25 cm X 25 cm were dug in each of the Ghasnis, roots were first separated manually as far as possible and subsequently by washing with running water using a sieve. Roots were also sun – dried and weighed to determine BGB (g/m^2).

2.4.2.2.2 Migratory Routes (MR)

Since migratory livestock spends considerable time in traversing from one forest to another forest to reach higher altitudes as well as while descending, a representative migratory route (Ropa – Dhela) in the Tirthan SWS was selected for vegetation assessment. 89 plots at 250 m interval all along migratory route for trees (12.61 m radius) and shrubs (5.65 m radius) as described in the case of village surrounds were laid and observations on tree and shrub species – their individuals; GBH; lopped, girdled and dead trees and tree regeneration were recorded. As migratory route trails were of narrow width (2-4'), the sample plots were laid in the proximity to the actual 250 m interval distance. The distance was measured by counting calibrated footsteps.

2.4.2.2.3 Transitory Forest Camping Sites (TFCS)

The livestock is allowed to rest at fixed locations in different forest openings, hereafter called as Transitory Forest Camping Sites (TFCS) after covering certain distance (8-10 km) while migrating. This facilitates night halts in pre-decided locations by the graziers and to establish their temporary camps. The livestock in TFCS gets rest, water, grazing requirement and more protection from wild predators than in forested tracts. In response to such short duration (2 – 3 days) camping, vegetation at each TFCS gets influenced due to trampling, concentrated grazing, manuring and other allied activities. Seven Transitory forest camping sites (**Table 2.4**) in Tirthan SWS were selected for vegetation assessment. The Table 2.4 provides basic details of each selected site and also the grazing pressure experienced by each pasture. The pressure was assumed considering the actual number of visiting sheep and goats, duration of their stay and overall size of the pasture visited. Broad three categories *viz.* Low, Moderate sand High grazing pressure were recognized.

Table 2.4 - Details of Selected Transitory Forest Camping Sites for Vegetation Assessment

Sl. No.	TFCS	Sub-watershed	Altitude (m)	Aspect	Size (ha)	No. of Sample Plots for Trees (12.61m)	No. of Quadrats (1X1 m)	Grazing Pressure (LIU)
1	Dulanga	Tirthan	2,640	South	2	9	-	Moderate
2	Shilt	Tirthan	2,880	South	6	9	-	Low
3	Pardi	Tirthan	3,120	South	5	9	-	Low
4	Rangthar	Tirthan	2,980	South	4	9	-	Low
5	Kundari	Tirthan	3,365	South	5	9	-	Moderate
6	Nara	Tirthan	3,320	South	3	9	75	High
7	Manjhouni	Tirthan	3,450	South	2	9	40	High

All sites were quantified for trees and shrubs as described in the above category of VS. Nine sample plots (12.61 m and 5.65 m radius) on three transects radiating from the centre of each TFCS were laid for tree and shrub level assessments. Two sites *viz*., Nara and Manjhouni (Sl. No. 6 and 7) were further assessed for herbaceous flora. Quadrats of 1m X 1m were laid for determination of composition and species diversity. The minimum size of the quadrat i.e. 1m X 1m was arrived using vegetation sampling techniques – 'species-area curve' as described by Mishra (1968). Similarly, the minimum number of quadrats required for sampling in Nara and Manjhouni TFCS were also worked out. Accordingly, 75 quadrats in Nara and 40 in Manjhouni TFCS were laid. The composition of herbaceous flora and species diversity in two TFCS was compared.

2.4.2.2.4 Alpine Pastures (AP)

The livestock utilise different Alpine pastures (>3600m) for a substantial duration during summer migration, being the ultimate destinations. Alpine pastures are thus major centres of resource utilization and also varied activities of graziers. As stated earlier, plants in AP are short lived and nearly for six months they remain covered under snow. During a short span of 2–3 months of livestock grazing. Alpine pastures are influenced in several ways. In view of this, vegetation and biotic assessments were carried out in nine (9) selected intensive study sites of Alpine pastures. Details of these nine sites and quadrats laid in each of them are given in the **Table 2.5**.

Table 2.5 - Details of Nine Selected Alpine Pastures for Intensive Studies

Sl. No.	Site	Sub-watershed	Altitude (m)	Aspect	Size (sq m)	No of Quadrats (1 X 1 m)	Grazing Pressure (LIU)
1	Ghumtarao	Tirthan	3,600	S	240	90	Low
2	Patal	Tirthan	3,620	S	200	50	Low
3	Mononi	Tirthan	3,610	S	18	40	High
4	Batlijani	Tirthan	3,630	S	256	80	Low
5	Bhlundwari	Tirthan	3,740	S	375	100	Moderate
6	Tharthadhar	Tirthan	4,000	S	140	40	Moderate
7	Saketi	Tirthan	4,240	N	169	40	High
8	Kobari	Tirthan	4,000	S	188	40	Moderate
9	Dhela	Sainj	3,800	N	406	100	Moderate

As all selected Alpine pastures were devoid of trees and shrubs, only herbaceous layer was quantified. The minimum size and number of quadrats required for sampling in each site were estimated (Mishra, 1968). The uniform size of the quadrat i.e. 1m X 1m was achieved which was used in laying varying number of quadrats in nine Alpine pastures as indicated in **Table 2.5**. The observations on the species composition and number of individuals were recorded in each case. The data was subsequently used for the determination of species diversity and evenness at each site while frequency, density and abundance of individual species at each Alpine pasture were determined. Details for these calculations are given in the following paragraph.

2.4.2.3 Vegetation Analyses

The vegetation data for different grazing resources *viz.* VS, MR, TFCS and AP was analysed using software packages – the MicroSoft EXCEL and SPSS. Data analysis was performed at two levels; firstly, for each site under one type of grazing resource and secondly, for the overall area by combining databases of all sites. These datasets were analysed for the following:

(a) Presence/absence of species by site, grazing resource type and entire landscape.

(b) Total number of families, genus and species - sitewise and overall category.

(c) Percentage frequency occurrence, abundance and density as per Misra, 1968.

(d) Diversity indices (Richness, Diversity, Evenness) using software package 'STATECOL' Programme in BASIC.

The vegetation data was analysed for frequency (F), density (D) and abundance (A). The term abundance and density represent the numerical strength of species in the community. Abundance if considered along with frequency, gives an idea of the distribution pattern of the species while the latter represents the number of individuals per unit area. The density and frequency taken together are of

prime importance in determining community structure and have a variety of uses far beyond those of other quantitative values (Mishra, 1968). Values of abundance, and density and per cent frequency for each species were computed using the following formulae:

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all sampled plots}}{\text{Number of sampling plots of occurrence}}$$

$$\text{Density} = \frac{\text{Total number of individuals of a species in all plots}}{\text{Total number of studied sample plots}}$$

$$\text{\% Frequency} = \frac{\text{Number of sample plots in which the species occurred}}{\text{Total number of studied sample plots}} \times 100$$

In the present study, tree measurements were made in sample plots of 12.61 m radius plot = 500 m^2, shrubs in 5.65 m radius plot =100 m^2 and ground layer in 1 X 1 m plot = 1 m^2. Tree density values are presented as number of trees/ha.

In addition, in the case of trees in village surrounds, Migratory Routes and Transitory Forest Camping Sites, the abundance (A), dominance (D) and Importance Value (I) of each species were calculated by a slightly modified method as described by Zhang and Cao (1995). The formulae used by them for A, D and I are given below:

A = (Ni/N)* 100; D = (Si/S)* 100; I = A + D, where Ni is the number of individuals in the *i*th tree species, N is the total number of individuals of all the tree/shrub species in the corresponding replicate plots; Si is total area (cross-section) at breast height of the trunks of all tree species in the plot. Likewise, dominance in case of each shrub species was also calculated.

Diversity Indices : Diversity of communities can be assessed using 'species richness' (measure of total number of species in a sampling area), species abundance model or evenness how the abundance data are distributed among the species) and indices based on the proportional abundance of the species. Over the years a number indices have been proposed for characterizing species richness and evenness. Such indices are termed as richness and evenness indices. For better clarity, these terms/ indices and their formulae are explained below :

Species Richness (NO) : The number of species in a community or in a sampling area is referred as species richness. Margalef (1958) has given an index for species richness:

Margalef index $R = S-1/ \ln (n)$

Where S = the total number of species in a community
N = sampling points

'Higher the value of R means greater species richness'.

Species Evenness or Equitability : Evenness refers to how the species abundances (e.g., the number of individuals, biomass, cover etc.) are distributed among the species.

Two prominent diversity indices *viz.* Simpson's Index (I) and Shannon's Index (H') are usually used. Whereas:

Diversity Index 1 Simpson Index - $\lambda = \sum_{i=1}^{s} p_i^2$

Where p_i is the proportional abundance of the ith species, given by

$$p_i = \frac{n_i}{N'} \quad i = 1, 2, 3, \ldots\ldots, S$$

Where n_1 is the number of individuals of ith species and N is the known total number of individuals for all S species in the population. Simpson's Index, which varies from 0 to 1, gives the probability that two individuals drawn at random from a population belong to the same species. Simply stated, if the probability is high than both individuals belong to the same species, then the diversity of community sample is low.

Diversity Index 2. Shannon's Index: H: The Shannon Index (H) has probably been the most widely used index in community ecology. It is based on information theory (Shannon and Weaver, 1949) and is a measure of the average degree of "uncertainty" in predicting to what species an individual chosen at random from a collection of S species and N individuals will belong. This average uncertainty increases as the number of species increases and as the distribution of individuals among the species becomes even.

The equation for the Shannon function, which uses natural logarithms (In), is

$$H' = \sum_{i=1}^{S^*} (p_i \ln p_i)$$

Where H' is the average uncertainty per species in a infinite community made up of S* species with known proportional abundances p_1, p_2, p_3 ……., ps ; S* and p_is are population parameters and, in practice, H' is estimated from a sample as

$$\sum_{i=1}^{S} \left[\left(\frac{n_i}{n} \right) \ln \left(\frac{n_i}{n} \right) \right]$$

Where n_i is the number of individuals belonging to the *i*th of S species in the sample and n is the total number of individuals in the sample.

"Maximum the value of H' means all S species are represented by the same number of individuals, that is, a perfectly even distribution of abundances".

Evenness Index (E) : When all species in a sample are equally abundant, it seems intuitive that evenness index should be maximum and decrease towards zero as the relative abundances of the species diverge away from evenness. Probably the most common evenness index (Ep) is by Pielou (1975) is referred as Pielou's equitability.

$$Ep = \frac{H'}{\ln(S)} = \frac{\ln(N1)}{\ln(N0)}$$

"The maximum Ep value means when all of the species in the sample are perfectly even".

2.4.2.4 Livestock Grazing and Wild Animals

The grazing resources throughout the world are extensively used by livestock and a variety of wild animals. They provide the majority of the nutrients for livestock and essentially all the nutrients for numerous species of large wild herbivores. Similar to elsewhere in the world, in GHNPCA too the organic component of grazing system is a complex of producers, consumers and decomposers that are organized into a food web. The GHNPCA due to its varied topography and altitudinal gradient harbours diverse wild animals representing different taxonomic groups. Since livestock utilizes various grazing resources across the altitudinal gradient during different time of the year, they often come into contact, share grazing resources, interact or compete with wild animals. Recognising the significance of these ecological relationships, and also considering the fact that any study on livestock grazing would remain incomplete without looking in totality. Thus, an attempt was made to generate desired information on prominent wild animals – their habitats, use pattern and their interactions with livestock using a systematic approach. The secondary information or researches carried out by co-workers under the major project were mainly relied since it was neither desirable nor feasible to assess the distribution, abundance and specific interactions of a diverse wild fauna in GHNPCA, in the present scope of the study. In addition to this, observations on direct sightings, indirect evidences (tracks and trails, dung, calls, feeding signs, etc) were meticulously recorded as and when encountered during the field ork in various grazing resource sites. Further, extensive interviews of local people, pastoralists and field staff were carried out and the valuable information provided by them helped in the overall synthesis on understanding of ecological interactions among livestock and wild animals. Field observations on allied activities of accompanying pastoralists to higher altitudes during migration and camping sites were also recorded.

2.4.3 Grazing Practices and its Socio-economics

The livestock rearing and management is an age-old practice and has been one of the main professions of local people in GHNPCA. Hence, livestock has direct relationship with human life style and their socio-economics. Pastoralism has a long history of its influence world over on the society, natural systems and Government policies and has also got influenced vice - versa. Keeping this fact in mind, the present investigations also aimed to assess the historical perspective, legal policies and provisions, socio-economics of dependent communities and their grazing management practices. A combination of several approaches including literature search (historical documents/reports, scientific research documentation, and official records of the Forest Department and Park management); interviews (local people, pastoralists and field staff); and field visits to selected village sites and grazing routes was used for qualitative and quantitative assessments. These assessments were mainly related to the migration pattern, type of livestock, their number, distribution and socio-economics.

Extensive as well as intensive field visits were undertaken to different sub-watersheds in order to cover representative villages and grazing sites. More than 50 field visits of varying duration ranging from average 3 days to 20 days were made during a 3-year study period. Village clusters in the adjacent 'Ani' Tehsil were also visited. A multiple check strategy was used to get the best possible estimate of total livestock population dependent upon the resources of GHNPCA. Pastrolists were first interviewed individually or in smaller groups at their respective village sites to ascertain their livestock holdings, migratory routes adopted by them and final destinations in Alpine pasture areas. This was followed by the first level cross check by intercepting migratory herds at the fixed entry/exist points in different sub-watersheds *viz*. Banjar, Gushaini, Bathad, Neuli, Jiwa, Rola, Sainsar, Lapah, Bah, Shangarh, Pashi, Raila and Mashyar. Livestock in each herd was enumerated and details on their origin, migratory routes adopted and time spent at various grazing resources were recorded. The livestock enumeration was conveniently carried out by strategically selecting narrow wooden bridges across rivers or narrow trail points. After a dialogue with pastrolists in each group and explaining the purpose of study, herders were usually convinced and they extended full cooperation in enumeration and responding to structured questionnaires. The second or final level check was carried out when these pastrolists with their migratory levels were either camping at the Transitory forest camping sites or Alpine pastures. Above-mentioned field visits also included systematic followings to at least all major and well-known migratory routes in different sub-watersheds. Maximum opportunities were also availed to have formal as well as informal interviews and interactions with field staff of the GHNPCA so as to have better insight on grazing practices and livestock-wildlife-human conflicts.

2.4.4 Livestock Grazing And Conservation Implications

The present study ultimately attempts to provide an insight on the livestock grazing vis-à-vis ecology, socio-economics and conservation of the landscape and its values. The availability of a series of technical reports on various physical, biological, sociological, management and monitoring aspects of GHNPCA by co-workers and national and international consultants under the FREEP-GHNP Research Project at its completion phase on one hand facilitated the overall understanding and synthesis. While on the other hand recent developments due to the final notification of the Great Himalayan National Park and consequent abrupt restrictions on the resource use by local people posed new challenges. Finally, a comparative account on the potential implications and management needs is projected using findings of the present study, professional knowledge and learnings from elsewhere visualising the following two broad scenarios:

(i) Regulation of livestock grazing by enforcement of law subsequent to the final notification, and

(ii) Continuance of current grazing practices.

CHAPTER 3 : THE LANDSCAPE, ITS ENVIRONMENT AND LIVESTOCK GRAZING

3.1 THE LANDSCAPE

Landscape can be variously defined. According to Forman and Godron (1981) landscape can be defined as a "kilometers-wide area where a cluster of interacting stands or ecosystem is repeated in similar forms". In other words, landscape is an area composed of interacting ecosystems that are repeated because of geology, landform, soils, climate, biota, and human influences throughout the area (Kaufmann *et al.* 1994). Landscape is generally of a large size, shape and pattern which is determined by interacting ecosystems. In the Himalayan system, the administrative, legal and social boundaries are usually delineated by the drainage system. Therefore, a landscape in such a situation can be a series of similar and interacting watersheds. To elaborate further, a landscape is constituted by pieces of land or mosaic characterized by their natural attributes, landuse pattern and by the kinds and extent of resource use practices and resultant changes in the physical and biological environments of the system (Sawarkar, 1995).

Ecologists, resource managers, and planners have traditionally ignored interactions among different elements in a landscape (Forman, 1981). However, it has now been realized that conservation efforts can succeed only by acknowledging the relationship between the physical, biological, ecological, socio-economic, political and administrative imperatives. Thus, the philosophy of maintaining biological diversity rests solely on the art of choosing the appropriate tools and approaches in being able to synergistically combine such combinations. Hence, a regional landscape planning approach demands an integration of ecological evaluation methodologies at hierarchical scales, from the smallest to the successively larger ones such as stand or site, multistand or multipatch and watershed level leading to the landscape level. In another words, an approach integrating assessments at macro (watershed or landscape) as well as micro (stand or site) levels is needed.

In light of the above and as stated in the previous Chapter, the GHNPCA was considered as one landscape. This landscape was assessed for its physical, biological, socio-economic environments while addressing issues relevant to livestock grazing in the region.

3.2 THE RESULTS AND DISCUSSION

The results on the physical, biological and social environments are presented one by one in the subsequent paragraphs.

3.2.1 Physical Environment

The topographical, geomorphic and climatic attributes constitute the physical environment in the region which leads into spatio-temporal variations in diversity and resource use patterns.

3.2.1.1 The Region

The Himalayas, a unique feature on earth, have been named variously the Abode of Snow, Abode of Gods, Weather-maker of the Indian Sub-continent, the Third Pole and the Weather Tower of Asia (Khoshoo, 1996). The Himalayan mountain range, due to its vertical and horizontal complexities, is probably the most diverse system in the world. Large altitudinal variations between the plains of the Himalayan foothills and highest peaks provide a great variety of natural and man-made ecosystems. Horizontally, the range extends from north to northeast and represents two prominent Indian biogeographic zones *viz.*, Trans-Himalaya and Himalayas and they combinely occupy nearly 10.9% of the country's geographical area (Rodgers and Panwar, 1988).

The compact block of GHNPCA comprising a National Park, two Wildlife Sanctuaries and an Ecodevelopment Zone encompassing a total area of 1,171 sq km acquires a grater regional conservation importance due to its contiguity with other adjoining PAs and managed forests.

3.2.1.2 Terrain and Sub – Watersheds

The terrain in the landscape is characterized by numerous high ridges (>4,000m), deep gorges and precipitous cliffs, craggy rocks, glaciers and narrow valleys. The perpetually snow bound area in the eastern part occupies 17.08% of the total landscape and drains out four perennial rivers (**Fig. 3.1**). Thus, the landscape under consideration consists of four sub-watersheds. Among four sub-watersheds, the Sainj SWS was the largest and occupied 39.62% area of the landscape while Jiwa SWS was the smallest, covering 12.64% landscape area (**Table 3.1**).

Table 3.1 - Four Sub-watersheds and their area

Sl. No.	Sub-watershed	Area (sq km)	Percentage Area of the landscape
1	Tirthan SWS	330	28.18
2	Sainj SWS	464	39.62
3	Jiwa SWS	148	12.64
4	Parvati SWS	229	19.56
		1171	**100**

3.2.1.3 Altitude

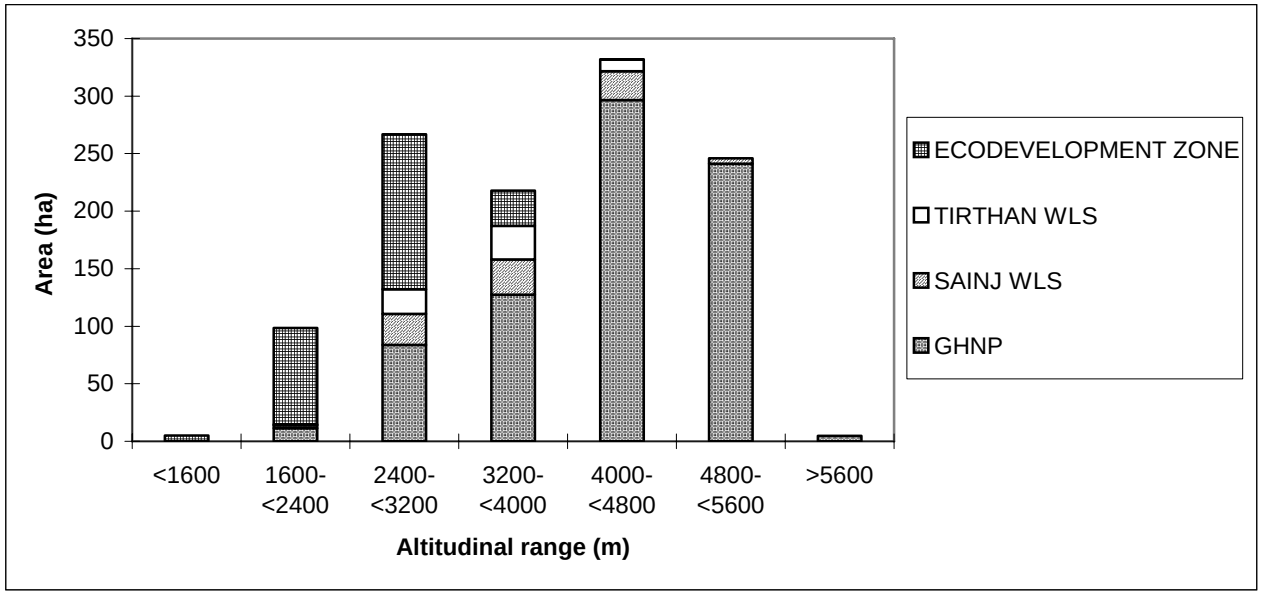
Landscape is featured by a marked altitudinal gradient ranging from 1,300 m to 6,110 m above mean sea level (Negi, 1996). The minimum altitude is at Seund which is the confluence of Sainj and Jiwa rivers while the maximum in Parvati SWS of an unnamed peak. In general, the altitude increases from west to east. The Ecodevelopment zone is located on the western periphery. Details on the distribution of area in different altitudinal zones are presented in **Table 3.2**.

Table 3.2 - Landscape area under different altitudinal zones.

Altitudinal zones (m)	<1600	1600-2400	2400-3200	3200-4000	4000-4800	4800-5600	5600-6400
Landscape area (sq km)	5.05	98.58	266.95	217.94	331.94	245.90	4.64
Percentage of landscape	0.4	8.4	22.8	18.6	28.4	21.0	0.4

It is noteworthy that on the one hand altitudinal variation results in diversity of forests and habitats while on the other hand altitude regulates spatio-temporal distribution of human and livestock populations and also their resource use pattern. Bulk of the temperate forests occur in lower altitudes (1,300-3,200 m) while summer grazing areas occur at > 3,200 m. The data on altitudinal variation among four administrative constitutuents (GHNP, Sainj, Tirthan WLS and EZ) revealed that >87% area of the Ecodevelopment Zone lies below 3,200 m elevation thus harbouring bulk of forest, greatly lacking alpine pastures. On the contrary three PAs had 83.9% of their total area at >3,200 m altitude (**Fig.3.2**), thus possessing disproportionately grater chunk of alpine pasture areas in comparison to the Ecodevelopment zone.

Fig 3.2 – Altitudinal Variations in the Four Administrative Constituents of the GHNPCA



3.2.1.4 Slope

Besides altitudinal complexities, the undulating terrain and steep slopes also characterize the land-scape. Four slope categories adopted for the present study influence resource use, and management of natural resources in one or the other way. The slope distribution data was analysed in three ways : (i) Sub-watersheds wise, (ii) Administrative unit wise, and (iii) overall GHNPCA.

3.2.1.4.1 Sub-watersheds : The values of Gentle slopes among four SWS varied from 14% (Tirthan SWS) to 21% (Jiwa SWS). More than 65% area of each SWS was under steep and very steep slopes (**Table 3.3**).

Table 3.3 - Slope Categories in Various Sub-watersheds (Values in %) of GHNPCA.

Sl. No.	Slope Category	Sub-watersheds				Overall GHNPCA
		Tirthan SWS	Sainj SWS	Jiwa SWS	Parvati SWS	
1	Gentle $<19^0$	15	14	21	20	16
2	M. Steep 19^0 - 26^0	11	11	13	12	12
3	Steep 27^0 - 45^0	41	37	40	29	37
4	V. Steep $> 45^0$	33	38	26	39	35

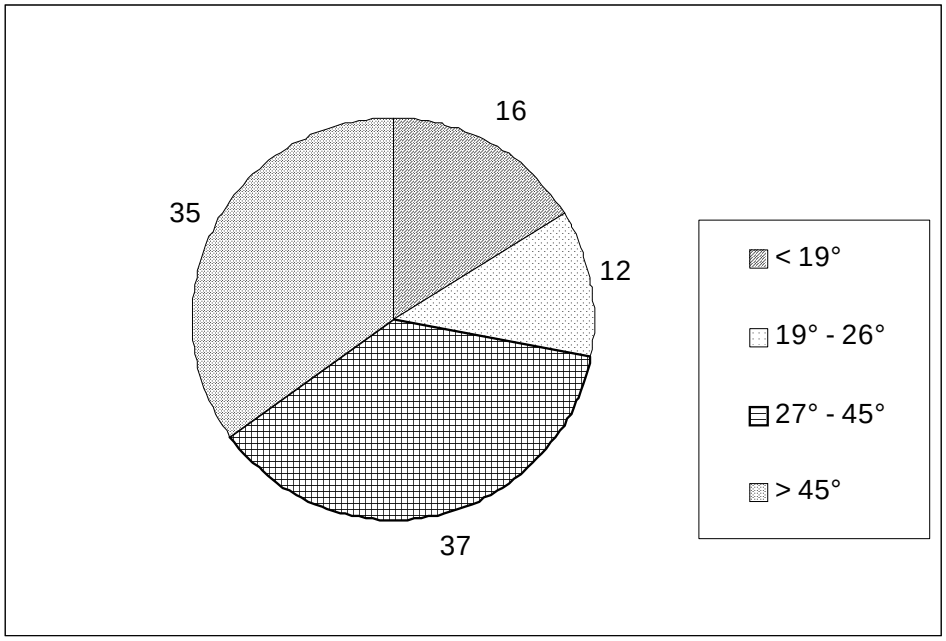
3.2.1.4.2 Administrative Units : Interestingly no marked distinction among four administrative constituents on the basis of slope categories was evident. However, it is worth mentioning here that only a small quantum of land (69 sq km or 5.89% of the total landscape) is just available in the Evodevelopment zone under the Gentle and Moderately Steep slope categories. This means that the entire human population residing in the 127 hamlets of EZ is directly dependent upon this meager land area for agriculture and horticulture purposes (**Table 3.4**).

Table 3.4 - Slope Categories in various Administrative Units (Area in sq km) of the GHNPCA

Sl.No.	Slope category	GHNP	Tirthan	Sainj	EZ	Overall GHNPCA
1	$<19^0$	134	9	9	39	191
2	19^0-26^0	87	6	12	30	135
3	27^0-45^0	262	24	51	98	435
4	$>45^0$	282	22	18	88	410
Total		**765**	**61**	**90**	**255**	**1171**

3.2.1.4.3 Overall Landscape : Analysis revealed that the entire landscape just possesses 16% land under the Gentle slope while > 70% of the landscape falls under Steep and Very Steep slope categories (**Fig. 3.3**).

Fig. 3.3 – Characterisation of the Landscape by Slope Categories (Values in %)



3.2.1.5 Climate

The GHNPCA experiences three distinct seasons *viz*., (i) Summer (April to June); (ii) Monsoon or rainy (July to September); and (iii) a six month long spell of winter (October to March). Like several PAs in India, the GHNP and two Sanctuaries also lagged behind in setting up the meteorological observatories at different locations. Data thus available for reference was mainly from two stations *viz.,* Niharni (1,800 m) in the Ecodevelopment zone and Sainj (1,450 m), outside GHNPCA. The Public Works Department is maintaining these two meteorological stations. It was only after the commencement of FREEP-GHNP Project, that on the initiatives of research team and support of the park management, three meteorological stations *viz.,* Kharoncha (1,800 m) in Tirthan SWS, Shangarh (2,100 m) in Sainj SWS and Pashi (1,500 m) in Jiwa SWS were established and regular data collection on rainfall and minimum and maximum temperatures on daily basis was carried out. Under the own new initiatives, rainfall and temperature data was also collected at three different locations in higher altitudes whenever such sites were visited and camped. Hence, broad observations based on the available or collected data are highlighted below.

The rainfall and temperature vary across the altitudinal gradient. The rainfall and temperature decreases as one ascends to higher altitudes. The temperature varies from – 20° C to 30° C during severe winter months of December-January and peak summer months (May-June), respectively. Depending upon the variation in altitude, higher reaches were colder than the valleys.

Average rainfall recorded at Niharni and Sainj during the period 1992-94 was 1,178 mm and 1,186 mm, respectively. Nearly 50% of the rainfall is received during the monsoon or rainy season, otherwise main precipitation is in the form of snow during winter. Occasional rains were also recorded during summer and winter months.

Higher reaches sometime experiences snowfall as early as the second fortnight of September. During the course of present study, the earliest snowfall was observed at Tirth in Tirthan SWS on 16 September, 1996 and as late as on 6 June, 1997. Except a few clear days, the upper reaches receive continuous rains throughout the monsoon season which causes over-flowing of river banks leading to land slides and erosion.

Long period of winter prohibits any outdoor activity in the region. Thus, local people have to mainly depend upon the stored resources (grains, fodder and fuelwood, etc.) and economy generated during the non-winter months. Out of that too heavy rains often take a toll of agricultural and horticulture crops. Due to these factors dependence on the livestock rearing for sustenance and also economy increases. Likewise, PA managers feel handicapped in carrying out protection works due to harsh weather conditions and inaccessibility of areas caused by damage of bridle paths and essential wooden bridges for any type of communication.

3.2.1.6 Landuse

In GHNPCA, as in other parts of the Himachal Pradesh, due to topographical intricacies and harsh climatic conditions, human population is traditionally dependent on forest and pasture resources for their own livelihood and rearing of livestock. Hence, forests and pastures play an integral role in the farming system prevalent in the region. During the post-independence period, the area witnessed increased agricultural activities and thus, a considerable area has been brought under agricultural system for production of grains. Even during recent 2-3 decades there is a gradual shift towards horticultural and other cash crops was observed.

Land, which is not privately owned, is controlled by the Forest Department or by the Revenue Department. Some revenue lands are classified as Government waste lands which are used by villagers and their grazing animals.

3.2.1.6.1 Overall Landuse Pattern : The landuse pattern obtained for the GHNPCA using the satellite data of 1993 is presented below in **Table 3.5**.

Table 3.5 – Overall Landuse Pattern in GHNPCA.

Sl. No.	Landuse Category	Area (sq km)	% of the Landscape
1	Forests	451.9	38.6
2	Grass Patches and Alpine Pastures	274.9	23.5
3	Rivers, Water Bodies and Permanent Snow	205.1	17.5
4	Rocky Slopes/Cliffs and Moraines	212.0	18.1
5	Habitations, Agriculture and Orchards	27.1	2.3
	Total	**1,171.0**	**100.0**

Different types of forests constitute the foremost category of landuse on the basis of actual forest area. Broadly two types of forests were recognized *viz.,* Temperate forests and Sub-alpine scrub. Temperate forests occur in the altitudinal range from 1,300 m to < 3,300 m while Sub-alpine scrub or Krummholtz dominated by *Rhododendron* sp. Occur between 3,300 and 3,600 m a.m.s.l. The temperate forests were further divided in two density classes on the bases of canopy cover (%): (i) Closed forest (> 40% canopy cover), and (ii) Open forest (10-40%). The second major landuse type was of the Grass Patches on lower altitudes and Alpine Pastures at > 3,600 m elevation. The area occupied by this category was 274.9 sq km or 23.5% of the landscape. Rivers, water bodies (lakes) and permanent snow occupied 17.5% of the landscape. The Rocky Slopes, Cliffs and Moraines also formed a significant landuse category by occupying 18.1% of the total land area. The village systems comprising habitations, agricultural areas and orchards covered just 27.1 sq km or a meager 2.3% of the entire landscape. The landuse pattern was further analyzed on basis of the administrative units and sub-watersheds.

3.2.1.6.2 Landuse Pattern – Administrative Units : The landuse pattern on the basis of administrative constitutents of GHNPCA is presented in **Table 3.6**.

Table 3.6 – Landuse Pattern in GHNPCA on the Basis of its Administrative Contituents (Area in sq km)

Sl. No.	Landuse Category	Constituents				Overall Landscape
		GHNP	Tirthan	Sainj	EZ	
1	Closed Forest	103.96	34.00	18.00	156.01	311.97
2	Open Forest	4.97	00.00	2.00	15.99	22.96
3	Grass Patches	16.98	1.00	2.00	33.99	53.97
4	Dry Alpine Scrub	85.99	8.99	15.98	5.99	116.95
5	Alpine Pastures	170.98	9.00	33.00	8.01	220.99
6	Rocky Slopes/Cliffs	157.97	7.00	14.99	8.01	187.97
7	Water Bodies	4.05	0.02	0.04	0.99	5.10
8	Permanent Snow	195.00	0.99	3.99	0.00	199.98
9	Habitation/Agriculture/ Orchards	1.07	0.00	0.00	26.01	27.08
10	Moraines	24.03	0.00	0.00	0.00	24.03
	Total Area (sq km)	**765.00**	**61.00**	**90.00**	**255**	**1171.00**

Significant observations made are highlighted below :

(a) The Ecodevelopment zone alone possesses more than 50% of the closed and open forests when compared with three other administrative constituents of the GHNPCA.

(b) The bulk (170.98 sq km or 73.37% of the total Alpine pastures lie in the GHNP area alone while the Ecodevelopment zone possessing the majority livestock of the GHNPCA had only 8.01 sq km or 3.62% of the Alpine pastures.

(c) The proportion of Grass patches occurring on lower altitudes was maximum in the case of Ecodevelopment zone, followed by GHNP. The EZ harboured 62.98% of total Grass patches.

(d) A vast proportion (>17%) of the landscape was under Permanent snow. Further, the vastness of these snow bound areas was evident in the case of GHNP. The GHNP alone harboured 97.51% of the total Permanent snow areas. This way, nearly one-fourth (¼) area of the

GHNP was snow covered. In contrast to the GHNP, the EZ was totally devoid of Permanent snow.

(e) As stated earlier, the Tirthan WLS was free from any human settlement. The GHNP and Sainj WLS have only meager areas under habitation and their agricultural areas. Strikingly, the dominance of habitations, agriculture and orchards was in the Ecodevelopment zone (**Fig 3.4**). Thus, 96.04% area under the permanent human use was located in the EZ. The habitations and cultivation areas alone occupied 10.2% of the EZ.

3.2.1.6.3 Landuse Pattern- Sub-watershed Basis : The appraisal of landuse data presented on the basis of Sub-watersheds revealed the following noticeable observations (**Table 3.7**) :

Table 3.7 – Landuse Pattern on the Basis of Sub-watersheds (Values in % of SWS area)

Sl. No.	Landuse Category	Sub-watersheds				Overall Landscape
		Tirthan	Sainj	Jiwa	Parvati	
1	Closed Forest	44.21	26.93	24.22	0.00	26.64
2	Open Forest	2.97	1.91	2.44	0.00	1.96
3	Grass Patches	6.13	4.22	8.66	0.36	4.61
4	Dry Alpine Scrub	10.90	10.29	9.70	8.51	9.99
5	Alpine Pastures	13.13	21.49	28.61	16.12	18.87
6	Rocky Slopes/Cliffs	13.99	17.30	16.36	17.10	16.05
7	Water Bodies	0.57	0.41	0.54	0.41	0.46
8	Permanent Snow	3.25	14.48	6.93	50.03	17.08
9	Habitation/Agriculture/ Orchards	4.91	1.31	2.25	0.00	2.31
10	Moraines	0.00	1.59	0.00	7.56	2.05

(a) By and large, each SWS had a resembling landuse pattern as of the entire landscape, except some obvious distinctions with regard to the categories of closed and open forests, Permanent snow and settlement areas.

(b) The Tirthan SWS on one the hand disproportionately possessed the bulk of the closed and open forests among four sub-watersheds. While on the other hand Parvati SWS was completely deficient in having any type of forest.

(c) Four sub-watersheds were not uniform with regard to distribution of Alpine pastures. The Sainj SWS possessed maximum area of Alpine pastures (99.71 sq km or 44.86% of total Alpine pastures). However, while comparing percentage figures for Alpine pastures in relation to the respective areas of each SWS, it was Jiwa SWS which obtained the highest value i.e. 28.61%.

(d) A skewed distribution of Permanent snow covered areas was highlighted earlier in favour of the GHNP. Likewise, an inconsistent pattern was noticed among four sub-watersheds. Over 50% of the Parvati SWS was under Permanent snow. Though 16.12% of the Parvati SWS was under Alpine pastures they were not available to migratory livestock due to its inaccessibility.

(e) More than 50% of the actual area under the category of habitations and cultivation was lying in Tirthan SWS. The use of forest resources by local people mainly for fodder and grazing by livestock; and diverse habitats by wild animals are directly associated with the distribution of landuse categories as listed in **Tables 3.5 to 3.7**. The close examination makes it amply clear that the four administrative constituents of GHNPCA were certainly not consistent with the available forest and pasture resources. Undoubtedly, the situation with regard to the availability of resources and landuse pattern was more analogous across four sub-watersheds.

3.2.1.7 Legal Status

The entire Landscape is covered under two broad legal categories *viz.,* (i) 'Revenue land' comprising villages, hamlets and cultivation areas under private ownership, and (ii) Government owned 'forest lands' comprising Reserved Forests (RF) or Protected Forests (PF). Protected forests have been further divided into three categories *viz.,* Demarcated PF Class I and Class II forests and undemarcated PF or Class III forests. They differ mainly on the basis of their location, composition, management and rights of their use by local people. A comparative description of forests under these three categories is presented in **Table 3.8**.

Table 3.8 – A Comparative Description of Different Protected Forests.

Sl. No	Type	Location	Quality of Forest	People Rights	Management
(i)	Demarcated Protected Forests – Class I	Near habitation, usually in lower elevations	Valuable growing forest stock	Less extensive but well defined	High level of management, Traditionally managed on the silvicultural system basis
(ii)	Demarcated Protected Forest – Class II	Comparatively in higher altitudes including alpine areas	Diverse vegetation types including pastures and snow bound areas providing large quantities of timber to local requirement and commercial purposes	Mainly used as summer grazing areas	Moderate level of management
(iii)	Undemarcated Protected Forests – Class III	Varying locations	Comprising wooded areas, grass patches and rocky barren slopes	People meet timber and grazing requirements	Low level management mainly due to poor demarcation and inaccessibility

RFs are better quality forests since they obviously enjoy higher legal status; and they are located in interior areas. The **Fig. 3.5** presents distribution of Reserved and Protected Forests (Class I and II) across the three administrative constituents *viz*., National Park and two Wildlife Sanctuaries. Information on PFs – Class III could not be accessed. The forests in GHNPCA were once managed as a part of the Seraj Forest Division. The Tirthan WLS, covering an area 61 sq km was first carved out and declared as 'Sanctuary' through the H.P. Government Notification in 1976. There are no villages inside the Tirthan WLS. The process of creating the Great Himalayan National Park was initiated way back in 1978-80, when the first Himachal Wildlife Project survey was undertaken. Based on the recommendations of the survey report, the first notification of intention to constitute GHNP vide H.P. Government Notification No. 6-16-73-SF-II dated 1 March, 1984 was issued. Since a few hamlets were falling in the initial notified park area and all efforts to relocate them have failed, the area was realigned and a new Sanctuary named as Sainj WLS was carved out. Further, considering the

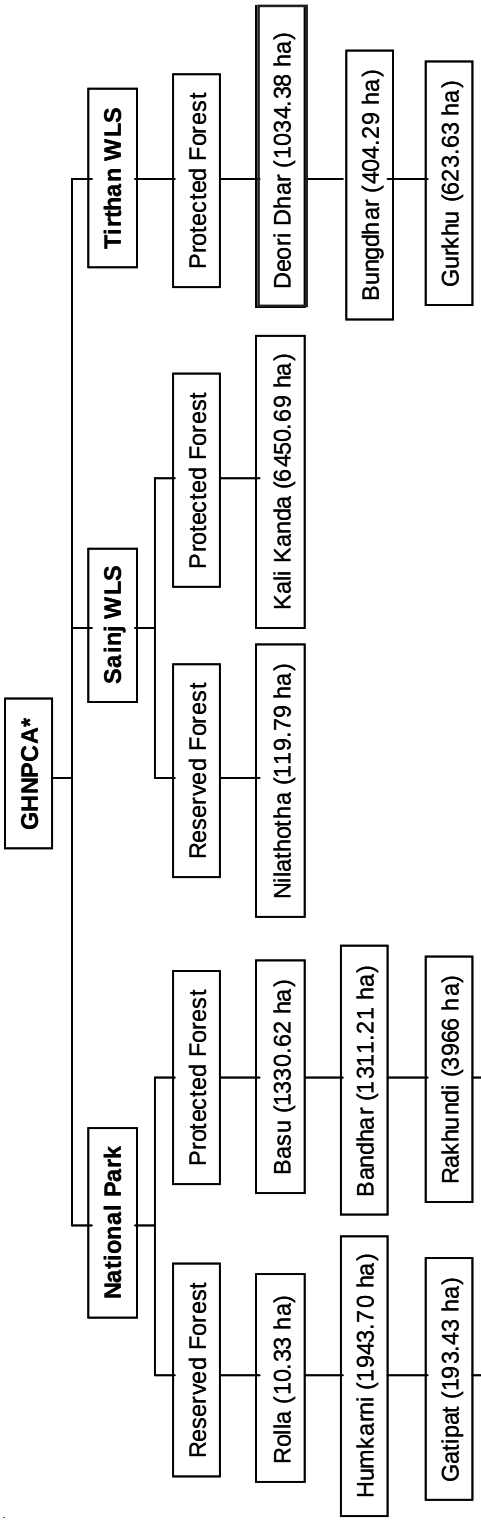


Fig. 3.5 - Distribution of Forests in GHNPCA

* Information for the Ecodevelopment zone and PF - Class III could not be accessed.

significance of a contiguous area in Parvati valley and additional area was added to the GHNP so as to enlarge the overall area to present 765 sq km vide H.P. Government Notification No.3-6-16-73-SF-II dated 22 April, 1994.

Further, an area extending radially upto 5 km on the western periphery of Tirthan and Sainj WLS as well as GHNP, covering 255 sq km was also demarcated as the 'Ecodevelopment Zone'. Though the Ecodevelopment zone harbours a number of villages, hamlets and cultivation area thus, constituting a bulk of 'revenue land' in spite this holds over 50% of the total forest area of GHNPCA. As explained earlier in para 2.1 under Chapter 2, the legal formalities for the final declaration of the Great Himalayan National Park remained pending for almost 15 years. However, it was only on the directives of the Supreme Court of India that the process of settlement was hastened and the final notification was issued in May, 1999 by settling rights of the local people by making a provision of cash compensation worth Rs. 1.5 crore to right holders. More than 50% of the cash compensation was already paid to the affected parties in the Ecodevelopment zone by the time of writing this document. The final award also made a provision of about Rs.7.5 crores for developing pasture lands, forest lands and medicinal plant areas during the period of next five years (*pers. Comm*. Park Authorities, GHNP). As stated by the Park authorities, due procedure in accordance to the Wildlife (Protection) Act, 1972 was followed for settlement. The final notification also resulted into a minor adjustment of 10.6 sq km between GHNP and the EZ. The revised area statistics has already been provided in the **Table 2.1**. Hence, the GHNPCA is now constituted by a NP, two WLS and an Ecodevelopment zone covering an area of 1,171 sq km for achieving long term conservation goal.

The GHNP and two WLS are fully under the control of the Director, GHNP, Kullu and being managed as per the provisions of the Wildlife (Protection) Act, 1972. The present EZ is mainly constituted by forests, grass patches ('Ghasnis'), alpine pastures and habitations alongwith their agricultural and orchard lands. Thus, a larger proportion of the EZ is Government owned forest land while the village and their surrounds form revenue area. The forest land is managed under the provisions of the Indian Forest Act, 1927 and the Forest Conservation Act, 1980 and also under the control of the Director, GHNP. While the revenue areas are under the control of the District Administration. The EZ makes the Buffer zone to three PAs.

The current legal provisions prohibit any type of resource use (grazing and collection of herbs, medicinal plants, etc.) in a National Park while only regulated resource use is permissible in a Wildlife Sanctuary. In such circumstances, the EZ becomes the Multiple Use Zone.

3.2.1 The Biological Environment

The landscape owing to large altitudinal and climatic variations alongwith varying land forms contribute a rich floral and faunal diversity. Prior to the initiation of FREEP-GHNP Research Project, only a general account on the floral and faunal attributes specific to GHNPCA was available. However, concurrent to the present study, several researches and short term consultancy studies were undertaken on different aspects. Findings of these recent researches were optimally used while synthesizing this section on the landscape. The floral and faunal diversity and its distribution across the landscape is thus described below.

3.2.2.1 Floral Diversity

The GHNPCA harbours varied forests (38.6%) and Pastures (23.5%). Hence, >60% area of the landscape is under one or the other type of vegetation. Old Forest Working Plans relevant to the area, describe the following 14 forest vegetation types as per Champion and Seth (1968) :

1. Ban Oak (*Quercus* sp.) Forest 12/C1(a)
2. Moist Deodar Forest 12/c1 (c)
3. Western Mixed Coniferous Forest 12/c1(d)
4. Moist Temperate Decidious Forest 12/C1(e)
5. Kharsu Oak Forest 12/C2(a)
6. Western Himalayan Upper Oak – Fir Forest 12/C2(b)
7. Montane Bamboo Brakes 12/DS1
8. Himalayan Temperate Parklands 12/DS2
9. Himalayan Temperate Pastures 12/DS3
10. Western Himalayan Sub-Alpine Fir Forest 14/C1(a)
11. Sub-Alpine Pastures 14/DS1
12. Birch/*Rhododendron* Scrub Forest 15/C1
13. Deciduous Alpine Scrub 15/C2
14. Alpine Pastures 15/C3

The *Aesculus indica, Juglans regia, Prunus cornuta, Acer* sp., *Betula alnoids, Betula utilis, Populas ciliata, Salix wallichiana, Fraxinus* sp., *Quercus leucotrichophora, Q.floribunda, Q.semecarpifolia, Celtis tetrandra* formed the broad leaved species whereas *Cedrus deodar, Pinus wallichiana, Apies pindrow, Pecia smithiana, Taxus baccata, Pinus roxburghii,* etc., were among the prominent confiers. Kharsu oak (*Quercus semicarpifolia*) occur in large extensive pure patches in the upper temperate zones

whereas *Abies pindrow and Pinus wallichiana* in the lower reaches than Kharsu oak which forms the sub-alpine forest reaching to the timber line. The riverine forests are dominated by the species of *Salix, Populus, Aesculus*, and *Prunus*. The Himalayan bamboo *Thamnocalamus spathiflorus* and *Sinarundinaria falcata* are usually found in moist slopes more in the northern aspect than in southern aspect. The major shrub species were the *Indigofera, Viburnum, Sarcococca, Berberis, Rosa* and in the higher altitudes the *Juniperus* and the *Rhododendron* form patches. The herb layer in the alpine areas is composed of many commercially important medicinal and aromatic plants like *Picrorhiza kurrooa*, *Dactylorhiza hatagirea, Aconitun heterophyllam, Jurinea macrocaphala* and *Nardostachys grandiflora* along with colourful species like the *Potentilla, Gagea, Geranium* and *Mecnopsis*.

Gaston *et al*. (1981) assessed distribution of large mammals and birds in GHNPCA on the basis of five broad vegetation categories. These are described below:

- Sub-tropical pine forests characterised by Chir pine (*Pinus rhoburghii*) and 600 – 1,700 m.
- Himalayan moist temperate forests characterised by both conifers and broad-leaved species between 1,500 – 3,600 m.
- Sub-alpine forests dominated by birch (*Betula* sp.) and fir (*Abies* sp.) between 3,000 – 3,400 m.
- Moist sub-alpine scrub characterised by *Rhododendron* species between 3,000 – 3,500 m.
- Dry alpine scrub characterised by Junipers (*Juniperus* sp.) between 3,400 – 3,800 m.

Singh and Rawat (1999) carried out systematic floristic surveys concurrently across GHNPCA during 1995 – 1999 in different forests and pastures in three seasons. A total of 832 plant species belonging to 128 families and 427 genera of higher plants were recorded. Habit wise distribution included 69 tree, 113 shrub, 493 herb, 96 grass and 27 ferns and 8 climber species. This represented nearly 26% flora of Himachal Pradesh. Further, an ethnobotanical survey undertaken by them revealed that local people use more than 250 plant species for various purposes. A number of species were recognised as locally threatened due to heavy exploitation, or rare due to their ecological and phytogeographical reasons. 15 species recorded in GHNPCA have been listed in the Red Data Book of Indian Plant (Nayer and Sastry, 1987). Singh and Rawat (1999) further described vegetation of GHNPCA into 11 physiognomic types that correspond to nearly 25 categories of Champion and Seth (1968). Thus, a detailed account on the floristics, species diversity, vegetation structure and composition, ethnobotany and conservation priorities for GHNPCA has been made available by them for the first time.

During the present study, it was noticed that the Himalayan Temperate forests, characterised by both conifers and broad-leaved species between 1,500-3,600m, dominate the landscape. Only two species of bamboo *viz., Sinarundinaria falcata* and *Thamnocalamus spathiflora* occur in GHNPCA. Both the species are important since as they form important wildlife habitat as well as heavily used by local people for making baskets ('Kilta').

It was also recorded that opportunistic plants *viz*., *Rumex, Polygonum, Impatiens, Girardiana,* etc. dominated ground cover in disturbed areas. *Themeda triandra, Heteropogon contortus, Andropogon lanceolatus, Carex sp., Apluda* sp. were prominent grass species in grass patches ('Ghasnis') in village surrounds. *Poa sp., Danthonia sp.* and *Phleum sp.* and *Carex* sp. were dominant among grasses and sedges in Alpine pastures. Lower plants *viz.,* Bryophytes and Lichens in GHNPCA have been studied by Singh *et al.* (1999), and Upreti (1999), respectively. So far, 150 species of Bryophytes and 192 species of Lichens have been identified and documented by them, respectively.

Lichens are the unique group of plants that consists of two unrelated components i.e. fungi and algae living in a close symbiotic association. The peculiar association enables these plants to exploit a wide range of habitats. Recent study on lichens in GHNPCA by Upreti (1999) disclosed a diversity of 192 lichen species belonging to 15 genera and 31 families. The Tirthan SWS and Jiwa SWS exhibit high diversity of 101 and 100 species, respectively. In contrast, the Sainj SWS represented 67 species only. The Shilt, Dhela and Gatipat have maximum species of lichens represented by 42, 40 and 34, respectively. Availability of several exposed rocks in alpine pastures provided opportunity to *Saxicolous* (rock inhabiting) species to grow. High diversity as of 40 Saxicolous species was recorded. The upper temperate forests (2,500-3,000 m) exhibit the highest diversity of lichens in GHNPCA. The Corticolous lichens (bark inhabiting) represented 149 species. Orchard species *viz*., *Prunus, Pyrus* sp. and *Juglans* sp. on lower altitudes while tree species belonging to genera *Aesculus, Betula, Celtis, Quercus, Rhododendron* and conifers were preferred host plants of lichens in GHNPCA. *Quercus semicarpifolia* tree harboured > 30 species. *Q. semicarpifolia* growing in different sub-watersheds exhibit a different pattern of species diversity, being higher in Tirthan and Sainj while least for Jiwa SWS. Common lichens in GHNPCA included *Acarospora fusca, Aspicilia almorensis, Bacidia millegrana, Caloplaca pindarensis, Leptogium pedicellatum, Lobaria retigera, Ramalina sinensis, Usnea longissima and U.orientalis*. A major trade in lichens for the purpose of making spices, medicines and dyes was is prevalent in the area. During the present investigations also, the harvest of lichens particularly by heavy lopping of *Quercus semicarpifolia* was witnessed.

3.2.2.2 Faunal Diversity

Noticeable variations in altitudes, aspects, slopes, valleys, ridges, peaks, forests, pastures at the macro or landscape level have already been highlighted. The typical terrain of GHNPCA was also rich in diverse microhabitat elements. A variety of unique and special habitats across the landscape provide additional value. The micro habitat elements of the geomorphic origin i.e. 'unique habitats' *viz*., rocky outcrops, cliffs, overhangs, caves/dens and bouldery stratum were some of the prominent features across different sub-watersheds. Likewise, micro habitat elements of the biological origin or 'special habitats' *viz*., numerous streams of different orders/riparian areas, lakes, grass patches, krummholtz (sub-alpine scrub), sacred groves (local 'Devta' or deity sites), bamboo dominated localized patches, down wood, snags, den trees, old growth stands are some outstanding endowment of the nature to the landscape. Obviously, above described macro and microhabitat elements contributed a spectacular, rich and diverse fauna. Prior to the present study and other concurrent researches under the major FREEP-GHNP Research Project, very little information was available on the faunal diversity in the area. However, significant contribution was made by Gaston (1980), Gaston *et al.* (1981, 1983 and 1993); Gaston and Garson (1992), based on several field surveys undertaken and by them under the foremost Himachal Wildlife Project. They present a general account of the types, extent and quality on forests and distribution of large mammals and pheasants in different administrative constituents and sub-watersheds.

Subsequent to the above and concurrent to the present study, systematic field surveys and detailed studies on different faunal groups undertaken in GHNPCA are described below:

A. Vertebrates			
	Mammals – Large mammals and a special focus on Mountain Ungulates		Vinod and Sathyakumar (1999); Vinod (1997 and 1999); Gaston (1998)
	Birds – Focus on Pheasants		Ramesh *et al* (1999)
	Herpetofauna		Dutta (1999)
B. Invertebrates			
	Annelids		Julka (1999)
	Molluscs		Julka (1999)
	Insects		Uniyal and Mathur (1998 a and b); Uniyal and Mehra (1996); and Uniyal and Singh (1996)

A gist on patterns of diversity, status and distribution of above faunal groups is presented one by one in the following paragraphs:

3.2.2.2.1 Mammals : Thirty one (31) mammalian species, representing six orders *viz*., Primates (2 species), Carnivora (12 species), Artiodactyla (7 species), Insectivora (3 species), Rodentia (6 species) and Lagomorpha (1 species) have been documented so far for the entire area. Primates were represented by *Rhesus macaque (Macaca mulatta)* and common langur (*Presbytis entellus*). These two primates were widely distributed across the temperate forests (1,440 – 3,420 m). The obvious absence in the Alpine pastures was noticed. Both the primate species preferred broad-leaved forests and village surrounds, mostly feeding on *Aesculus indica, Juglans regia* and agricultural crop – *Zea maize* and fruits in orchards. Among Carnivora, 12 species recorded so far are: Common leopard (*Panthera pardus*), Snow leopard (*Unicia uncia*), Asiatic black bear (*Ursus thibetanus*), Himalayan Brown bear (*Ursus arctos*), Jackal (*Canis aureus*), Red fox (*Vulpes vulpes*), Wolf (*Canis lupus*), Leopard cat (*Felix bengalensis*), Jungle cat (*Felis chaus*), Yellow Throated marten (*Martes flavigula*), Himalayan weasel (*Mustela sibirica*) and Himalayan Palm civet *(Paguma larvata*). Four of these *viz*., snow leopard, Himalayan Brown Bear, Himalayan Weasel and Red fox are predominantly preferred higher altitudes (> 3,300 m) i.e. sub-alpine and alpine zones. Only one sighting record in the case of snow leopard by

Vinod (1999) has been documented. On the contrary, common leopard, Asiatic Black Bear, Himalayan Brown Bear, Jackal and Red Fox were frequently sighted during this study. Yellow-throated marten was usually sighted in pairs, near streams and grass patches across different sub-watersheds. Usually the frequent sightings were between 1,400 to 2,800 m elevations.

Seven species belonging to the Order Artiodactyla or ungulates *viz*., Grey Goral (*Nemorhaedus goral*), Himalayan Musk Deer ((*Moschus chrysogaster*), Himalayan Tahr (*Hemitragus jemlahicus*), Serow (*Nemorhaedus sumatraensis*), Barking deer (*Muntiacus muntjak*), Blue Sheep or Bharal (*Pseudois nayaur*), and Asiatic Ibex (*Capra ibex*) have been listed for GHNPCA by Gaston *et al.* (1981) and Vinod and Sathyakumar (1999). During the present study goral were frequently sighted. The species was widely distributed from 1,600 m to 3,000 m. Usually sightings were on southern grassy slopes and in and around the Transitory forest camping sites. The Himalayan Tahr preferred steep, rocky slopes at altitudes ranging from 2,600 - > 4,000 m. On the contrary direct sightings of the Himalayan Tahr were low. Himalayan Tahr as a solitary to five individuals in a group were sighted near Gumatrao, Kobari, Dhela, Majhouni, Manoni, Apgain, Gatipat during September-October and June-July. The musk deer being a territorial animal was mainly seen in sub-alpine scrub dominated by *Rhododendron campulatum* or Krummholtz while foraging was observed in alpine pastures. Sightings of Musk deer in Gumatrao, Kobri, Dhela and Patal were made during the intensive field assessments in sub-alpine and alpine pasture areas. Blue sheep as an animal of alpine pastures and scree slopes and precipitous cliffs at altitudinal range of 3,800 – 4,700 m were sighted on six different occasions during the course of present investigations. The group size varied from 8 to 40 individuals. Majority of these sightings were over Bhlundwari area and Tarthadhar in Tirthan SWS. At least on two occasions Blue sheep were sighted while they were licking on salt licks left behind by pastrolists. These sightings were made in the second half of September month, once pastrolists have vacated pasture areas after intense use. As such Blue sheep were not sighted in alpine pastures while the migratory livestock was present in those pastures. The Barking deer, an inhabitant of middle to upper temperate forests was rarely sighted. Serow, an animal of mid to upper temperate forests though reported in GHNPCA was never sighted during the study period. Likewise, not a single sighting of the Himalayan ibex was recorded during the 3 year field work though the GHNPCA provides a potential habitat.

Six species belonging to orders Rodentia and Lagomorpha *viz*., House mouse (*Mus musculus*), Common Giant Flying Squirrel (*Hylopete fimbriatus*), Royle's vole (*Alticola roylei*), Indian Porcupine (*Hysterix indica*), Hodgson's Porcupine (*Hystrix hodsoni*), and Himalayan Mouse Hare – Pika (*Ochotono roylei*) have been documented so far. The Himalayan mouse hare was frequently sighted. This species was sighted only in alpine pastures having predominance of boulders. The maximum sightings were at Kobri, followed by Tarthadhar i.e. >4,000m elevation. Usually these sightings were in afternoons. 11

sightings of Common giant flying squirrel on trees of *Aesculus indica* and *Quercus semicarpifolia* were recorded during the present study. Only one direct sighting of Indian Procupine near Tinder village in Tirthan SWS was made. However, quiils of these species as indirect evidence were very frequently seen around village surrounds.

Among above described 31 mammalian species, 11 have been listed as Schedule I species, and 9 as Schedule II species under the Wildlife (Protection) Act, 1972.

3.2.2.2.2 Avifauna : Gaston et al. (1994) documented 183 bird species in GHNP including 132 passerines and 51 non-passerines. They also concluded that the Park supports a substantial proportion of all the species occurring within its altitudinal range in the Western Himalayas. At least 50 species are summer visitors to the Park. Two raptors – Himalayan Griffon (*Gyps himalayensis*) and Lammergier (*Gypaetus barbatus*) are common in the GHNPCA. The GHNPCA is well known for supporting a viable population of many endemic Western Himalayan pheasants, particularly the endangered Western tragopan (*Tragopan melanocephalus*). Other four species of pheasants reported from GHNPCA are: Cheer pheasant (*Catreus wallichii*), Himalayan monal (*Lopophorus impejanus*), Koklas (*Pucrasia macrolopha*) and Kalij (*Lophura leucomelana*). Ramesh *et al* (1999) have provided details on the altitudinal and seasonal distribution of five pheasants in GHNPCA. Kalij pheasant occurs in the lower temperate broad-leaved forests with sufficient undergrowth, while Koklass pheasant primarily occur in the upper temperate broad leaved and conifer forests. The Himalayan monal prefers extensive range of habitats and altitudinal distribution. The Western tragopan occurs between 2,600-3,200 m elevations, hence they utilize mainly the broad leaved conifer, mixed conifers and Kharsu oak (*Quercus semicarpifolia*) forests. The cheer pheasant is rarely sighted. However, a few sightings were made in the broad-leaved conifer forests. The distribution pattern of five pheasants illustrates utilization of different forest types located in middle altitudinal range. A Western tragopan was successfully captured for the first time by the Wildlife Institute of India's research team and released after installation of radio-transmitter. Data on the seasonal movement and habitat use is being collected.

3.2.2.2.3 Herpetofauna : Field surveys for the assessment of diversity, distribution and status of herpetofauna (reptiles and amphibians) across different sub-watersheds were undertaken for the first time under the major project. A list of 12 species has been provided by Dutta (1999). The Himalayan Pit Viper (*Agkistrodon himalayanus*) was frequently sighted, especially during the rainy season. During one field trip of 18 days (Rolla to Saketi), as many as nine Himalayan pit vipers were sighted. Other common reptiles sighted were Indian rat snake (*Ptyas mucosus*), Kashmir rock agama (*Laudakia tuberculata*) and Himalayan ground skink (*Scincella himalayanus*). Rat snakes were sighted during May-June and August-September.

3.2.2.2.4 Annelids and Molluscs : The earthworm fauna (annelids) in GHNPCA is represented by 11 species, comprising about 25% of diversity recorded in Himachal Pradesh. Of these, 4 species are native and 7 are exotic. High earthworm diversity in the area was recorded. It was mainly due to the availability of diversity habitats *viz.,* moist forests with thick layer of litter, animal dung, rotten logs, bouldery stratum and bark of standing trees, etc. Two new species of the genus *Plutellus* were recorded and identified from the GHNPCA (Julka, 1999). The study by Julka (1999) has also highlighted that native species are usually found under natural vegetation while introduced exotics predominate cleared areas for cultivation, plant nurseries and in dung heaps near cowsheds. An inventory of molluscs in GHNPCA yielded a list of 14 species. The reason for poor diversity of aquatic molluscs was accounted for the absence of stagnant water bodies. Of 14 species recorded, 10 were terrestrial and 2 aquatic.

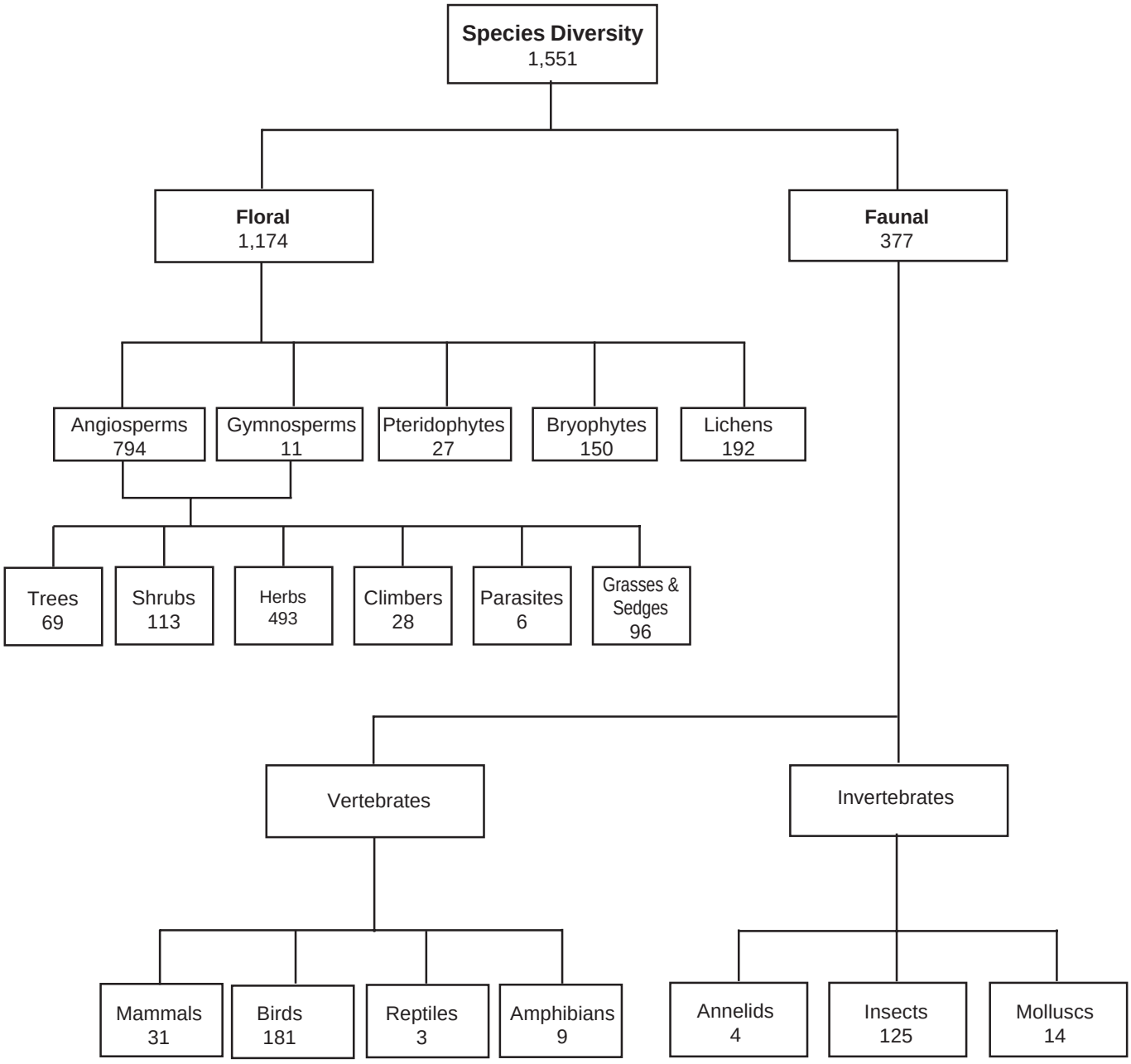
3.2.2.2.5 Insects : The recent study on insects belonging to six selected orders *viz.,* Coleoptera, Hymenoptera, Diptera, Hemiptera, Odonata and Lepidoptera revealed a diversity of 37 families, 108 genera and 127 species among specimens identified (Uniyal and Mathur, 1998). The order Lepidoptera (butterflies and moths) represented higher diversity in terms of 55 genera and 61 species among the six orders studied. The order Coleoptera (beetles) had 41 genus and 47 species. Studied six orders were arranged in a descending diversity sequences as: Lepidoptera – Coleoptera – Hymenoptera – Odorata – Hersiptera – and Diptera. Out of 37 families recorded, seven families were widely distributed (1,500 - > 3,500 m) while seven other families had a narrow distribution (1,500-2,000 m). Out of 14 families recorded of the order Coleoptera (beetles) maximum representation of species was recorded in the family Scarabacidae (dung beetle). As the name suggests, members of this family mostly feed on dung of various large herbivores which they roll into convenient – sized ball, burry them in underground chambers and feed at leisure. Apparently, there seems to be a positive correlation between livestock grazing and diversity of dung beetles. This requires further confirmation and monitoring. Uniyal and Mathur, (1998) revealed that among the 13 families of the order Lepidoptera recorded, three prominent families were *viz*., Nymphalidae, Pieidae and Papilionidae. Significantly only these three families representing maximum diversity were recorded from alpine pastures. It is therefore, presumed that any deleterious effect on alpine pastures may influence the diversity of these three insect families.

The figure provides a summary of floral and faunal diversity so far documented in the case of GHNPCA **(Fig. 3.6)**.

3.2.3 The Social Environment

Mountainous landscapes are of paramount importance for the biosphere and humanity. Since time immemorial, man has colonised and exploited natural high altitude ecosystems for himself and his

Fig. 3.6 - Sumary of Floral and Faunal Diversity in GHNPCA



livestock. The landscape under consideration is no exception. Diverse ecosystems, man and his livestock have co-evolved and are thus, intimately tied as a complex fabric. In this context, it becomes important to examine and understand the social conditions of the local people, particularly of pastrolists, historical development, perceptions and attitudes.

The synthesis on the social environment of local people and pastrolists presented below is largely based on the assessments made in field and villages as per the methodology described in the previous Chapter, however, supplemented by findings of co-workers.

Tucker (1997) has provided a comprehensive account of the historical development of human impacts on the GHNPCA while Nangia *et al*. (1999) have dwelt upon the socio-economic conditions of resource dependent people. Baviskar (1998) has presented an overview on resource use practices, perceptions, resource conflicts and their negotiation based on an intensive micro-study in Sharan and Lapah villages in Sainj SWS.

3.2.3.1 The Historical Perceptive

The historical development in the area was understood for three broad eras : (i) Pre-colonial Kingdoms, (ii) Colonial System, and (iii) Post-Independence Period.

During the Pre-colonial kingdoms, people were asked to pay taxes, provide labour and various produces and products to rulers in return for rights of access to various resources. This era was followed by an administrative system under the British colonial regime wherein linkages between the State and people were meticulously codified in terms of 'duties' and 'rights'. This colonial phase was more or less bureaucratic as well as hierarchial wherein the policy decisions were always by the top. The best aspect of the British regime was that details of various rights to land and other natural resources *viz*., right of way, collection of forest produces, livestock grazing, etc. were well documented and because of this people felt more secure. The Post-independence Period witnessed a sea change. This period was greatly influenced by increasing demands and market forces. However, this was not true in the case of pastrolism. The age-old practice of seasonal transhumance pastrolism and their life style largely remained unaffected in spite of major changes in different ruling regimes, new technologies and overall development.

3.2.2.2 The Social System

The social and land tenure systems in the area follow a strict caste centered approach. The caste system has thus influenced the social structure, work distribution and resource use. In general, people

are social and simple. People are highly religious and follow 'Hinduism'. Each village is having its own '*Devta*' or local deity. People have strong faith in '*Devta*' and '*Devta*' becomes part and parcel of all rituals, ceremonies, fairs, and conflict resolution mechanisms. Thus, the entire village community is tied up with this village level social institution. In comparison to several other areas in the country, by and large the area has remained backward. There is a high level of illiteracy among men and women folks. Most of the villages in GHNPCA still lack access through proper road network. Except small-scale handloom industries, the area is devoid of any other type of industry. The area followed to continue the old legacy specifically with regard to rights and concessions extended during the colonial period. At the same type, people faced new challenges on the account of abrupt changes in policies, law, rapid developmental activities, market forces, greater politicisation and exposure to the outer world. This way, the natural resource, its dependents and administrators all got affected. Today, the local people have become victims of uncertainties, insecure rights and growing conflicts.

3.2.3.3 The People and their Life Styles

Human settlements in the region came into existence well over 2,000 years ago in the form of small mountain villages (Ohri, 1980 and Tucker, 1997). Villagers adopted agriculture and pastrolism as their main professions. The available literature revealed that the agricultural practices in the region has undergone drastic changes over the past several decades with the advent of modern technologies. The Government took a lead in providing electricity to each household and drinking water facility. The major development and prosperity brought in the area is due to a major shift from cereal crops to cash crops and finally to horticulture. In general, two crops per annum *viz*., 'Kharif' during rainy season and 'Rabi' during winter are harvested. The maize (*Zea mays*) occupies about ¼ area under of the Kharif crops, followed by Sariyara (*Amaranthus hybridus*) covering nearly 15%. Rajma (*Phaseolus sativus*) is grown in about 10% area as a major pulse crop during Kharif. Wheat (*Triticum aestivum*) is grown as the major Rabi crop which covers > 30% of the agricultural area. Rice (*Oryza sativa*) was the second major crop during Rabi, grown in about > 15% area. More than 12 different crops are grown during Kharif season while only 3 crops (wheat, rice, mustard) are cultivated as Rabi crops (Nangia *et al.* 1999).

More than 70% of households had a mixed economy i.e. a combination of agriculture, horticulture and animal husbandry. Nearly 10% households had their income from agriculture and collection of medicinal plants. Rest 20% households got their incomes mainly by specialised occupations or Government service. It is difficult to find any household without having any type of livestock. The type and number vary among different household. Details are presented in Chapter 5. In general, atleast 15-20 sheep and goat with majority of households is a common feature. The overall number of sheep and goat are nearly equal, precisely sheep is slightly on the higher side.

Nearly 1/3rd of the total population was economically weak i.e. less than Rs.5,000/- cash income per annum. Another 1/3rd fall under low income group (Rs.6,000 – Rs. 10,000/- per annum). Likewise, rest one-third constituted the high income group having cash income of > Rs.11,000/- per annum

(Nangia *et al.* 1999). This high income group also included a small proportion (7%) of wealthy people. In recent years, the local economy has been further strengthened by a growing trade in herbs and medicinal plants. In spite development and changes brought in, the overall life style of the local population is still dependent upon forest resources. Till recent months, people have enjoyed various rights and concessions for utilising forest and grazing resources in GHNP. The final declaration of GHNP in recent months has resulted into withdrawal of such privileges enjoyed by local people over past 100 years or so.

The land is still ploughed by bullock, though a number of households keep a small number of cows for milk but they are never taken to the alpine pastures during summer migration. A substantial number of sheep and goat are owned by most of the households and their number per household increases with the higher location of villages. People seldomly own buffalo for religious reasons, thus sheep and goat form a bulk of the livestock population in GHNPCA. Most of these sheep and goat are taken to the alpine pastures for summer grazing, apart from this a substantial number of sheep and goat from the proximate neighbourhood and 'Ani' Tehsil visit GHNPCA during summer and monsoon months and utilize various grazing resources. The houses and livestock sheds are mainly made of wood houses. People generously use wood of *Abies pindrow, Cedrus deodar, Pinus wallichiana and Picea smithiana*. A certain amount of wood under old norms of rights and concessions is availed from the Forest Department. However, people use much more wood than is usually provided. Special wooden structures for storage of food grains and fodder are also constructed so as to use those during harsh winter months. Villages are mostly scattered in the lower temperate forest or EZ.

The distribution of villages in different administrative constituent units across the landscape and their human population are presented in **Table 3.9**. The various administrative units in a Revenue District can be arranged in an ascending order as: household (family) → hamlets (a sub-village → 'Phanti' (a revenue village) → Kothi' (a cluster of villages) → 'Waziri' (Sub-Tehsil) → 'Tehsil' (a revenue sub-block) → Block District.

There is no village in the finally notified National Park (GHNP) and Tirthan WLS. The Sainj WLS possesses two tiny hamlets *viz*., Shakti and Maror forming a part of Garapali Phanti or revenue village. The Ecodevelopment zone harbours remaining 125 hamlets under 13 revenue villages. As per the District Census figures, there were 2,313 families (households) constituting a total human population of 13,145 persons. As such the administrative distribution of villages was irrespective of sub-watersheds. However, the further analysis of population data presented in Table 3.9 revealed that among four SWS, the maximum households (1033) having human population of 6,073 was in Tirthan SWS, followed by 768 households with 4,250 persons in Sainj SWS while the minimum population (2,822) lived in Jiwa SWS. The fourth SWS i.e. Parvati SWS was devoid of any human settlement **(Table 3.10).**

Males constituted 51.96% of the total human population. The male : female ratio was 1:0.92. The Schedule Castes and Schedule Tribes together constituted 29.64% of the total human population.

Noticeably, only 16.63% of the female population was literate while 58.09% male population was illiterate. The overall literacy rate was just 30.30%, much below than the average national literacy level.

The main diet is composed of cereals (wheat, maize and rice), pulses and vegetables. People prefer non-vegetarian diets, mainly of sheep and goat mutton on special occasions. Poultry farming in GHNPCA is uncommon. Hence, people are dependent upon nearby markets for chicken and eggs. Green vegetables (Spinach, Lettuce, Brinjal, Cucumber, Tomato, Chillies, Cabbage, Cauliflower) and potato are grown mainly for self-consumption. Milk production is as such low. However, they obtain sufficient milk production for self-consumption and also for making 'Ghee' (Purified butter) and curd. People also consume walnut (*Juglans regia*) as dry fruit. Fruits *viz*., apple and peaches are also dried for use during winters. Apple, Plum and Peaches are grown extensively in orchards. Most of the households own some quantity of frutit trees in orchards. The sizes of these orchards vary with the economic status of family. The landholdings varied from 5 to 50 'bighas' (Nangia *et al.,* 1999). Five bighas make an 'Acre' (1 ha = 2.5 Acres). Nearly 10% household possessed > 5 bighas. 36% household had > 3 bighas. Otherwise, an average holding was about 15-20 bighas.

Despite varying castes, land holdings, literacy, occupations, income groups among villagers of GHNPCA, the role of livestock in the life style and livelihood of the majority of the population remains of paramount importance. While habitations, farm land, forests, grazing areas and markets are static in nature but the only mobile component across the entire landscape is a pastrolist or his livestock. Thus, pastrolism becomes the hub or a linking factor for the different components.

By and large, the age old traditional ways of specialised seasonal resource use, mixed economy and simple life style had provided self – sufficiency to the local population. However, with the every passing day the complexity of problems mainly on the account of: (i) increasing human population, growing demands influence of market forces, conflicts, uncertainties; (ii) faulty land use practices; (iii) curtailment of seasonal spatial resource use; and (iv) over-burdening of limited and depleted available resources has already started disrupting the traditional sustainable ways and leaving permanent scars. Realising this tenet concerning doubtful sustainability of natural resources and self sufficiency of local people, the Government of Himachal Pradesh with the external aided funding had initiated a major 5-year Project for the conservation of biodiversity in GHNPCA adopting an ecodevelopment approach. Thus, in past 4-5 years, by adopting a participatory approach involving all stakeholders and formation of Village Ecodevelopment Committees (VDCs) a modest beginning has been made in the right direction. The success ultimately depends on the greater participation and sincerity at all levels.

Table 3.9 – Distribution of Villages and Human Population in GHNPCA

Sl. No.	Waziri	Kothi	Phanti	No.of Hamlets	No.of Households	Total Population
1	Rupi	Balhan	Railla	19	512	2822
		Sainsher	Sainshar	29	302	1606
			Garaparli	7	116	592
2	Inner Seraj	Banogi	Suchen	5	202	1212
		Sangarh	Shangarh	14	111	618
			Lapah	4	37	222
		Palach	Kalwari	2	43	252
			Srikot	7	78	417
		Sarchi	Shilli	4	137	812
		Nohanda	Pekhri	16	187	1098
			Tinder	6	123	677
		Tung	Chipni	6	245	1537
			Mashyar	8	220	1280
	Total	**8**	**13**	**127**	**2313**	**13145**

Table 3.10 – Distribution of Population Among Four Sub-watersheds

Sl.No.	Sub-watershed	Households	Human Population
1	Tirthan SWS	1,033	6,073
2	Sainj	768	4,250
3	Jiwa SWS	512	2,822
4	Parvati SWS	-	-
Total		**2,313**	**13,145**

3.2.4 Cross Linkages and Spatial Distribution of Resources

The foregoing results and discussion have broadly described physical, biological and social environment across the landscape and its linkages with pastrolism. However, for a better understanding different sectoral linkages (agriculture, forests, wild animals and livestock) and a spatial distribution of various resources and their users are depicted in Fig. 3.7. The typical west-east transect across altitudinal gradient in a sub-watershed illustrates that habitations, agriculture and horticulture was mainly confined to lower elevations comparing with prominent wild ungulates, carnivores, pheasants and highly demanded medicinal herbs, livestock (sheep and goat) had widest spatial distribution across the gradient of altitude and different forest types. Each of the six major plants (*Viola serpens, V. odorata, Morchella esculenta, Usnea longissima, Jurinea macrocephala, Dactylorhiza hatagirea, Aconitum heterophyllum, Picrorhiza kurrooa*) being harvested for meeting increasing market demands showed narrow niche. The vastness of the landscape in terms of its span and altitudinal variation has thus provided a bounty of variety and variability of ecosystems, habitats, and species and their interactions.

3.2.5 The Grazing Resources

The above analysis has shown that the practice of pastrolism in GHNPCA is semi-nomadic and livestock therefore, traverses widest altitudinal range during three seasons and utilize different grazing resources. The reconnaissance prior to the present intensive study was able to reveal four types of grazing resources *viz.,* (i) the village pastures ('Ghasnis') and their surrounds (VS), (ii) Forest resources across migratory routes (MR), (iii) Transitory forest camping sites (TCFS) and (iv) Alpine Pastures (AP).

3.2.5.1 Village Pastures : The village pastures ('Ghasnis') are grass dominated areas in village surrounds, mostly on the southern aspect. These village pastures either lies in the revenue area of undemarcated Protected Forests – Class III. Generally each revenue village ('Phanti') has got atleast some area of Ghasnis. As already stated, there was lack of available information on the PF – Class III mainly due to undemarcation of such areas (Table 3.8). However, based on the resource mapping and landuse analysis, it was known that the Evodevelopment zone possessed about 34 sq km area under Ghasnis or Grass Patches. Based on field observations, it can also be stated here that the size of Ghasnis ranged from 150–300 ha. Ghasnis are optimally protected for 6-7 months i.e. April-October. This is the time when majority of livestock is away on summer migration except a few stall-fed cows and bullocks. Thus, vegetation in Ghasnis is allowed to fully grow during summer and rainy seasons. This way plants particularly grasses are able to complete their critical part of life cycles. The seed formation, seed dispersal and translocation of food reserves and storage in underground roots or rhizomes take place in the case of perennial grasses. Once grasses have grown, reached their peak

production level, matured and dried, they are harvested and stored as hay during October-November. The harvest and storage operations are usually carried out by female members of each household and they complete these operations prior to the se in of severe winter or snowfall. Later, livestock on their return from migration is permitted to graze on the remnants of grass or litter scattered on ground during the harvest operation.

3.2.5.2 Grazing Resources Along Migratory Routes : During upward and downward movement, livestock utilizes ground vegetation in lower temperate, upper temperate, sub-alpine scrub forests. Pastrolists occasionally facilitate grazing by lopping of trees during migration. Likewise, villagers also collect fodder from trees from adjoining forests specially during winter months so as to feed cattle. Details of trees lopped are provided in the Chapter 4. As such, a minimum impact is made on the forested tract during migration. Firstly, the migratory herd uses only narrow selected trails for their movement. Thus, only a small proportion of the forest area is used and affected by the migrating sheep and goat. Secondly, pastrolists usually rush their herd to the specified Transitory forest camping sites (TFCS) so as to reach well before dark and to avoid livestock predation.

3.2.5.3 Pastures : Two type of pastures (locally called 'Thatches') depending upon their location in GHNPCA and origin were recognised. These two broad categories included the : (i) TFCS as forest openings mainly due to biotic activities, and (ii) Alpine pastures (AP) – mainly natural in origin at above 3,600 m altitude. The former is further divided into three types based on altitudinal range and forest types. These three types were : (i) Mid Temperate (MT) – 2,000 to < 2,800 m; (ii) Upper Temperate (UP) – 2,800 to < 3,300 m; and (iii) Sub-Alpine (SA) – 3,300 to < 3,600 m. Alpine pastures in GHNPCA occur above the natural tree line. In TFCS, the ground vegetation is predominantly herbaceous with short, green and tender shoots. The TFCS are anthropogenic in origin, mainly due to the combine effect of gradual removal of woody vegetation, burning and grazing.

3.2.5.3.1 Listing, Mapping and Distribution of Pastures : Prior to the initiation of present investigations, reliable and systematic baseline information on such pastures (Thatches) across the Landscape of GHNPCA was not available. Thus, a major effort during the tenure of present study was made to list and map pastures and also to assess their distribution across different forests and sub-watersheds. These pastures are those which were visited by pastrolists and used by their livestock for camping and grazing.

A total of 161 pastures were identified, listed and mapped **(Fig 3.8)** for the entire landscape. These pastures were located at varying altitudes ranging 2,180 m to 4,600 m. Beyond this altitude (4,600m) in most of the cases there was the permanent snowline.

The distributional analysis of 161 pastures those were visited by pastrolists on the basis of administrative units, sub-watersheds and aspects is discussed.

(i) Administrative Units : The Table 3.11 revealed that 111 or 68.94% pastures were located in GHNP alone. Another 30 or 18.6% pastures were in two other PAs i.e. Tirthan WLS and Sainj WLS. Therefore, only 20 pastures or 12.42% of the total pastures visited by pastrolists were located in the Ecodevelopment zone.

Table 3.11 – Distribution of Pastures by Administrative Units.

Sl. No.	Administrative Unit	No. of Pastures	Percentage of Total Pastures
1	Great Himalayan NP	111	68.94
2	Tirthan WLS	14	8.70
3	Sainj WLS	16	9.94
4	Ecodevelopment zone	20	12.42
Total		**161**	**100.00**

(ii) Sub-watersheds and Aspects : The data analysis on the distribution of pastures across three sub-watersheds indicated that there was no marked difference in their number in three sub-watersheds. The Tirthan SWS had maximum number i.e. 64 pastures those were visited by pastrolists, followed by 57 in Sainj WLS and the least 40 in Jiwa WLS **(Table 3.12).** In general, the distributioin of pastures was skewed in favour of south aspect (59.63%).

Table 3.12 – Distribution of 161 Pastures across Sub-watershds and Different Aspects.

Sl. No.		Sub-watersheds						Overall Landscape			
		Tirthan SWS		Sainj SWS		Jiwa SWS					
	Aspect → / Categories ↓	N	S	N	S	N	S	N	S	Total	%of Pastures
1	Mid Temperate (2,000-<2,800 m)	3	3	4	2	1	1	8	6	14	8.70
2	Upper Temperate (2,800 - < 3,300 m)	5	12	6	7	1	11	12	30	42	26.09
3	Sub-Alpine (3,300 - < 3,600m)	9	9	5	10	0	6	14	25	39	24.22
4	Alpine (>3,600 m)	17	6	8	15	6	14	31	35	66	40.99
Total		**34**	**30**	**23**	**34**	**8**	**32**	**65**	**96**	**161**	**100.00**

A list of 161 pastures, their locations and aspect is given in **Table 3.13.**

Table 3.13 - List of Pastures (Thaches) in the GHNPCA

Sl. No	Sub-Watershed	Aspect	Pasture	Altitude (m)	Category
1	TIRTHAN	N	DUNGA	4450	AP
2	TIRTHAN	N	MUNGRA DWARI	3870	AP
3	TIRTHAN	N	CHHADAR	3200	UT
4	TIRTHAN	N	MANDRACH	2320	MT
5	TIRTHAN	N	BAGARIS	2430	MT
6	TIRTHAN	N	JASU	3210	UT
7	TIRTHAN	N	NARAGI	3080	UT
8	TIRTHAN	N	MUNNI ROPA	3780	AP
9	TIRTHAN	N	BASLEO	3400	SA
10	TIRTHAN	N	RATA DABAR	3760	AP
11	TIRTHAN	N	KER	3640	AP
12	TIRTHAN	N	BHUJ	3680	AP
13	TIRTHAN	N	MANJNIKOT	3860	AP
14	TIRTHAN	N	BADI	2815	UT
15	TIRTHAN	N	CHHODAR	3600	AP
16	TIRTHAN	N	MUNDREUR	3360	SA
17	TIRTHAN	N	BASHEL	3580	SA
18	TIRTHAN	N	DETI	3660	AP
19	TIRTHAN	N	SHAGOT	2860	UT
20	TIRTHAN	N	KHORIL POLI	2680	MT
21	TIRTHAN	N	CHANONI	3340	SA
22	TIRTHAN	N	ASHURBAGH	3790	AP
23	TIRTHAN	N	SARI	3380	SA
24	TIRTHAN	N	PHUPHU	3440	SA
25	TIRTHAN	N	JHATHOLI	3460	SA
26	TIRTHAN	N	DHARACH	3680	AP
27	TIRTHAN	N	BHOGARA DUNGA	3860	AP
28	TIRTHAN	N	UMBLIDWARI	3800	AP
29	TIRTHAN	N	KHUKHARI	3850	AP
30	TIRTHAN	N	CHANNI	3560	SA
31	TIRTHAN	N	KHOL	3840	AP
32	TIRTHAN	N	BANDYOG	3640	AP
33	TIRTHAN	N	DEOBANI	3800	AP
34	TIRTHAN	N	SAKETI	4240	AP
35	TIRTHAN	S	THARTHADHAR	4000	AP
36	TIRTHAN	S	BHLUNDWARI	3740	AP
37	TIRTHAN	S	BATLIJANI	3630	AP
38	TIRTHAN	S	CHANG	3590	SA
39	TIRTHAN	S	BAKRETU	3579	SA
40	TIRTHAN	S	MANJHOUNI	3450	SA
41	TIRTHAN	S	CHAKRER	3590	SA
42	TIRTHAN	S	DWARIGARH	3120	UT
43	TIRTHAN	S	SHANKHA	3100	UT
44	TIRTHAN	S	RAKHALTI	3000	UT
45	TIRTHAN	S	BALU	3010	UT
46	TIRTHAN	S	HARA	3290	UT
47	TIRTHAN	S	NARA	3320	SA
48	TIRTHAN	S	KOBRI	4000	AP
49	TIRTHAN	S	BHARENGCHA	3950	AP
50	TIRTHAN	S	CHALOCHA	2320	MT

Contd...

Table 3.13 Contd...

Sl. No	Sub-Watershed	Aspect	Pasture	Altitude (m)	Category
51	TIRTHAN	S	GHARANI	2560	MT
52	TIRTHAN	S	DULANGA	2640	MT
53	TIRTHAN	S	SHILT	2880	UT
54	TIRTHAN	S	PARDI	3120	UT
55	TIRTHAN	S	BHUJDWARI	3210	UT
56	TIRTHAN	S	GHUMTAROA	3590	SA
57	TIRTHAN	S	PATAL	3620	AP
58	TIRTHAN	S	MANONI	3590	SA
59	TIRTHAN	S	KOLCHI	3210	UT
60	TIRTHAN	S	PALNI	2820	UT
61	TIRTHAN	S	GURAT	3010	UT
62	SAINJ	N	SHILI DANSWARI	3920	AP
63	SAINJ	N	DOTLA	3620	AP
64	SAINJ	N	NIARI NAINA	3680	AP
65	SAINJ	N	NALA TAPRA	3880	AP
66	SAINJ	N	MATI NAINA	3440	SA
67	SAINJ	N	CHARKERA	3720	AP
68	SAINJ	N	KILI	3840	AP
69	SAINJ	N	KAMBA	3760	AP
70	SAINJ	N	TUNDA BHUJ	3400	SA
71	SAINJ	N	DUDLA	3120	UT
72	SAINJ	N	HUMKHARNI	2800	UT
73	SAINJ	N	MANJHAN GALU	3300	SA
74	SAINJ	N	DHELA	3800	AP
75	SAINJ	N	PITTA	3560	SA
76	SAINJ	N	SHUNGCHA	3550	SA
77	SAINJ	N	UKKHAL	3400	SA
78	SAINJ	N	DUGGI	3260	UT
79	SAINJ	N	RAJ THATTI	3205	UT
80	SAINJ	N	SARAH	3080	UT
81	SAINJ	N	THATI	2200	MT
82	SAINJ	N	THINI	2180	MT
83	SAINJ	N	JAGNAHU	2615	MT
84	SAINJ	N	KHARU	2600	MT
85	SAINJ	S	MUNDA TAPRA	3990	AP
86	SAINJ	S	MANJ KA TAPRA	3950	AP
87	SAINJ	S	RATI DWARI	3880	AP
88	SAINJ	S	INDRA	3790	AP
89	SAINJ	S	RAL	3510	SA
90	SAINJ	S	JAOLA	3440	SA
91	SAINJ	S	PALTA	3340	SA
92	SAINJ	S	RAKTI TAPRA	3640	AP
93	SAINJ	S	GHUGHUMUA	3680	AP
94	SAINJ	S	JOARA(I)	3550	SA
95	SAINJ	S	RAHNI	3520	SA
96	SAINJ	S	JAUVIA	3360	SA
97	SAINJ	S	MAJHAUN	3200	UT
98	SAINJ	S	AVNI	3080	UT
99	SAINJ	S	RAKTIKHOL	3100	UT
100	SAINJ	S	PARKACHI	3060	UT

Contd...

Table 3.13 Contd...

Sl. No	Sub-Watershed	Aspect	Pasture	Altitude (m)	Category
101	SAINJ	S	MATHAUN	4100	AP
102	SAINJ	S	JARAUN	3860	AP
103	SAINJ	S	JOARA(II)	3600	AP
104	SAINJ	S	RATI NARI	3360	SA
105	SAINJ	S	SALTU	3320	SA
106	SAINJ	S	KAILI	3000	UT
107	SAINJ	S	CHYAS	2970	UT
108	SAINJ	S	BARAMCHULI	2860	UT
109	SAINJ	S	KARCEHER	2720	MT
110	SAINJ	S	THUMRI	3740	AP
111	SAINJ	S	GALU	3530	SA
112	SAINJ	S	GARWARI	3940	AP
113	SAINJ	S	DUDI CHAN	3860	AP
114	SAINJ	S	BAHLI	3880	AP
115	SAINJ	S	THELRU	3540	SA
116	SAINJ	S	SOCHA	3600	AP
117	SAINJ	S	MURLI	2760	MT
118	SAINJ	S	RAKTI SAR	3880	AP
119	J.	N	DISHARI	3680	AP
120	JIWA	N	PANIHARU	3800	AP
121	JIWA	N	SILIRARI	3280	UT
122	JIWA	N	KHUTAR KA BAN1	3750	AP
123	JIWA	N	DEUN	2200	MT
124	JIWA	N	RADHAUNI	3860	AP
125	JIWA	N	BAROHI	4335	AP
126	JIWA	N	KANDI	3627	AP
127	JIWA	S	KHUTAR KA BAN2	4360	AP
128	JIWA	S	RANKA	3820	AP
129	JIWA	S	RATICHHO	3760	AP
130	JIWA	S	TALYAHARU	3700	AP
131	JIWA	S	BAGRI	3800	AP
132	JIWA	S	CHANGAR	3580	SA
133	JIWA	S	LAHLI BATI	3920	AP
134	JIWA	S	MILI DWAR	3600	AP
135	JIWA	S	DUARA	3200	UT
136	JIWA	S	UKHAL PATTHAR	2920	UT
137	JIWA	S	MAJHAN	3400	SA
138	JIWA	S	GARA DAURA	3450	SA
139	JIWA	S	SHILILUARI	4280	AP
140	JIWA	S	RATI THATI	4033	AP
141	JIWA	S	ROHNI	4000	AP
142	JIWA	S	KHANERSU	3960	AP
143	JIWA	S	HARI	3360	SA
144	JIWA	S	ATHADUG	3000	UT
145	JIWA	S	BIRAGHMAR	3600	AP
146	JIWA	S	BIRA	3500	SA
147	JIWA	S	APGAIN	2840	UT
148	JIWA	S	JUBKUTAN	3000	UT
149	JIWA	S	BAKARCHUNA	2900	UT
150	JIWA	S	BECHA	3480	SA

Contd...

Table 3.13 Contd...

Sl. No	Sub-Watershed	Aspect	Pasture	Altitude (m)	Category
151	JIWA	S	DWARA	3200	UT
152	JIWA	S	MORGAIN	3200	UT
153	JIWA	S	DRASHER	3800	AP
154	JIWA	S	LIGAN	3000	UT
155	JIWA	S	SHILPHAR	3200	UT
156	JIWA	S	BHAKHILCHIN	2800	UT
157	JIWA	S	CHHOGAD	2200	MT
158	JIWA	S	PHAGCHI	4600	AP
159	TIRTHAN	S	KUNDARI	3365	SA
160	TIRTHAN	S	DASHMANI	3100	UT
161	TIRTHAN	S	RANGTHAR	2980	UT

* - Sl No. 1 to 161 of pastures as shown on Fig 3.6

MT - Mid Temperate
UT - Upper Temperate
SA - Sub- Alpine
AP - Alpine Pastures

3.2.6 Conclusion

(1) Nature has endowed the landscape with a spectacular diversity of land forms, haitats and floral and faunal species. The altitude was a decisive factor for resultant diversity and resource use pattern. Despite agriculture including horticulture being the main profession in the GHNPCA, pastrolism still remained the central point of traditions, life style, activities, economy, self sufficiency, sectoral linkages, (pastures – forests – agriculture – household – market), and overall influence. The landscape, its constituent administrative units and sub-watersheds, landuse and grazing resources are summarized in **Fig 3.9.**

(2) The land and the people have witnessed different periods of governance, shift in policies, development and exposure to the outer world. Despite this, the landscape persisted to be rich in diversity while people continued to be simple and followed the traditional ways of living, especially in the case of pastrolism.

(3) A well defined seasonal as well as highly spatial distributed resource use strategy adopted by people, livestock and wild animals was an insurance for sustainability and a device for lesser conflicts. This well established system of sustainability in spite difficult terrain and harsh climate is gradually getting perturbed due to abrupt changes brought in agricultural and livestock grazing practices, policies and increasing market influences.

(4) In a high altitude landscape, typical as that of the GHNPCA, the use of watershed approach seems to be the best option for delineation, demarcation, administration and distribution of natural resources, their use and management.

Fig. 3.9 - The Landscape, Landuse and Grazing Resources