Management Plan
Rupi Bhaba Wildlife Sanctuary, Himachal Pradesh

April 2010 - March 2015

R. Jayapal

Group for Nature Preservation and Education, Chennai

&

K. Ramesh

Wildlife Institute of India, Dehradun

March 2010

Photo Credit: John Corder [Western Tragopan]
K. Ramesh [Cover Pages]
Navendu Page [Flora and Vegetation Types]
Pranav Chanchani [People - Forest Interface]

Citation:

Jayapal R. and Ramesh K. 2010. Management Plan for Rupi-Bhaba Wildlife Sanctuary, Himachal Pradesh [April 2010 - March 2015]. Wildlife Institute of India, Dehradun. pp 163 + vii.

Management Plan for

Rupi Bhaba Wildlife Sanctuary, Himachal Pradesh

[April 2010 - March 2015]

Team Leader and Coordinator

K. Ramesh, Ph.D.
Scientist - C

Department of Landscape Level Planning and Management
Wildlife Institute of India, Dehradun

Consultant

R. Jayapal, Ph.D.
Program Head

Research and Policy Development
Group for Nature Preservation and Education, Chennai

Technical Support

Navendu Page
Ph.D. Scholar
Indian Institute of Science, Bangalore

Pranav Chanchani
Ph.D. Scholar
Colorador State University, USA

March 2010

Foreword

For Himachal Pradesh, this is perhaps the first Management Plan for a Protected Area that draws its basic approach from IUCN Guidelines for Planning and Managing Mountain Protected Areas, looking into (a) biological and ecological issues, (b) economic issues, (c) social issues, (d) legal and institutional issues and (e) political issues. Good planning and practicable strategy are critically linked to the reliability and quality of the knowledge base relevant to the PA. In this context, developing a Management Plan for Rupi Bhaba Wildlife Sanctuary had to be carried out in the backdrop of an insufficient knowledge base; logistic constraints, an inhospitable terrain and harsh climatic conditions. Although rich in biodiversity, this Sanctuary is exploited for various societal needs, and thus, conflicts with conservation priorities are inevitable. Therefore, before the Management Plan writing, far ranging and extensive survey work was undertaken to develop a representative and usable baseline data. This was supplemented with historical and socio-economic information through iterative interaction with field staff and local people. The reader would discover that this plan has placed primary importance on the biological character of the WLS, and that the prescriptions are provided in an unconventional format. The chapters on management effectiveness (Chapter 6) and road map (Chapter 7) are user friendly guidelines for the PA manager. While the biological components have been argued strongly, the plan recognizes the gap or inadequacy in resources including capacity building, and suggests way forward to address these issues.

Due process of presentation and inviting comments and suggestions from a range of forest officers of the forest department were carried out and where relevant these were incorporated. Overall, the management plan is refreshingly bold in its approach, and given the short period and limited resources, the plan is a commendable effort by Dr K Ramesh and his team. I do hope that concerned PA managers and staff would find this a useful document that should take management efforts in Rupi Bhaba WLS to the next level, by the time this plan is due for revision after five years.

Vinay Tandon
Principal Chief Conservator of Forests (Wildlife)
Himachal Pradesh

March, 2010

Preface

Mountains are undoubtedly one of the most vulnerable ecosystems on the earth. Though they harbour a spectacular diversity of wild flora and fauna, often unique to the mountain habitats, they are also under severe pressure from local communities who are dependent on the ecosystem goods and services provided by mountains for their livelihood and sustenance. Therefore, management of mountain Protected Areas has always been riddled with challenges and dilemmas.

When we were offered the opportunity of drafting a management plan for Rupi Bhaba Wildlife Sanctuary, we were only glad to accept it as we thought it would give us an opportunity to put into practice our long research experience with the wildlife conservation and management in the Western Himalayas. But we soon realized that the task ahead was not less than daunting as the challenges were manifold: first, the severe paucity of information about the sanctuary… its flora and fauna, physical features, socio-economic profile of people living in the sanctuary, and management history. Our only sources of information were the first management plan written by Sanjeeva Pandey in 1991, which was truly innovative for that period, and an immensely readable travelogue of Kinnaur Valley by Sanan & Swadi (1998). In fact, a majority of people whom we spoke to for secondary information had only a vague idea of the existence of the sanctuary! This information gap also posed the next biggest challenge… to come up with a team of subject matter specialists to collect authentic primary data on all aspects of the sanctuary within a short time. When we, as a team, eventually landed up in the sanctuary in April 2008 to do the field survey, we were appalled to see the derelict state of management affairs in the sanctuary: a lackadaisical leadership, severe shortage of human resources, near-absence of essential infrastructure, generally demoralized frontline staff, rampant instances of illegal activities inside the core area, and growing antagonism between the management and the local communities.

But there were some silver linings too: a highly motivated section of the field-staff, spectacular mountain and alpine landscape, remarkable species diversity of flowering plants, mammals, birds, and other fauna, presence of a good population of some of the rarest wildlife species like Western Tragopan, Serow, and Snow Leopard, and enormous tourism potential that the sanctuary holds. Realizing the conservation potential of the sanctuary for the Himalayan wildlife and habitats and endless possibilities of engaging the local communities in its management, we took it as a challenge to come out with this management plan.

In this process, we were hugely assisted by several people both in the forest department and outside. It would not have been possible for us to achieve this task

without their prompt and timely assistance. First, we are grateful to Mr. Vinay Tandon, IFS, the PCCF for his unfailing confidence in us and constant support throughout the project. Mr. A. K. Gupta, IFS, former Chief Wildlife Warden, was kind enough to extend the project period and provided much needed impetus to complete the task rapidly. We are also grateful to Mr. Sanjeeva Pandey, IFS (CCF - FD & PA) and Mr. K.S. Thakur, IFS (CF-Wildlife, Shimla) for their generous support all through the project activities. We thank Mr. Satish Gupta, IFS (DFO-Wildlife at PCCF-CWW Office), Dr. Lalit Mohan, IFS (CF-Simla Circle), and Mrs. Sangeeta Chandel (ACF at PCCF-CWW Office) who facilitated our field survey in Rupi Bhaba Sanctuary. We place on record the number of officers who offered comments/critique on the draft management plan during the presentation made on 23.10.09 at Shimla, and subsequently through email communication. We are deeply indebted to all of them.

In the field, we were ably supported by the Sanctuary management led by Mr. O.P. Solanki, IFS (then DFO-Wildlife, Sarahan Division), Mr. P. Thirumal, IFS (present DFO-Wildlife, Sarahan Division), Mr. Sandeep Sharma (ACF-Wildlife, Sarahan Division) and all the field-staff. In particular, we hugely appreciate Mr. R.S. Negi, Deputy Ranger, Rupi Range, Mr. Ram Das, Block Officer, Rupi, Mr. Harish Chandra, Deputy Ranger, Katgaon Range, Mr. Roop Singh, Forest Guard, Katgaon Beat, Mr. Parma Nand Draik, Forest Guard, Chota Kamba Beat, and Mr. Shyam Lal, chowkidar and guide at Salaring Beat for accompanying us on several expeditions in the field and sharing with us their enormous knowledge of the landscape and wildlife. We also enjoyed the company of the young Forest Guards on probation who had just returned from their training and were attached to us in our field-surveys for hands-on training; they included Mr. Surya Negi, Forest Guard, Tabo Beat in Spiti Valley, Mr. Bhola Singh, Forest Guard, Kaza Beat in Spiti Valley, Mr. Bhupender Singh, Forest Guard, Kandhar Beat, RBWLS, Mr. Suresh Sharma, Forest Guard, Shango Beat, RBWLS, and Mr. Pankaj Kumar, Forest Guard, Nathpa Beat, RBWLS.

Besides, there were several people from local villages who volunteered to furnish information to us regarding the socio-economic issues of the Sanctuary and we are grateful to them for those fruitful discussions we had with them. The support staffs on our field-trips were extremely courteous and helpful and we would not have been able to successfully complete the surveys in a harsh and precipitous terrain like Rupi Bhaba without their able guidance and facilitation. Among them, we would like to particularly thank Mr. Khan Singh, guide at Rupi Range, Mr. Debi Chand, Mr. Ram Dayal, Mr. Ramesh Negi, Mr. Jagannath, and Mr. Sanjay, guide at Katgaon Range.

Back home at Wildlife Institute of India, Dehradun, we would like to place our sincere gratitude to Mr. P.R. Sinha, the Director, Dr. V.B. Mathur, the Dean, Dr. G.S.

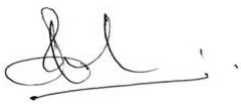
Rawat, Scientist-G, Dr. S. Sathyakumar, Scientist-F and Dr. Karthikeyan Vasudevan, Scientist-D for their unflinching support and enthusiasm.

Finally, we would like to thank the other members of survey team comprising Mr. Niladri B. Kar and Mr. Prudhviraj, Wildlife Institute of India, Dehradun [survey of herpetofauna], Mr. Pranav Chanchani, currently a Ph.D. Scholar at Colorado State University, USA [socio-economic survey in Bhaba Valley], and Mr. Navendu Page, currently a Ph.D. Scholar at Indian Institute of Science, Bangalore [vegetation survey in Bhaba Valley]. We also thank the management of Group for Nature Preservation and Education (GNAPE), Chennai for generously expending the services of RJ for writing the management plan.

Given the existence of several resource inadequacies and information limitations, we are fully aware that a work of this nature can hardly be claimed to be comprehensive or complete. Therefore, we welcome any suggestions or criticisms that would improve the scope and efficiency of the management plan, and we request readers to bring to our notice any factual errors or discrepancies in statements therein.

Date: 22 March 2010
Place: Dehradun

R. Jayapal, Ph.D.
Consultant
Program Head,
Research and Policy Development,
Group for Nature Preservation and Education, Chennai



K. Ramesh, Ph.D.
Team Leader & Coordinator
Scientist-C,
Department of Landscape Level Planning and Management,
Wildlife Institute of India, Dehradun

Table of Contents

Chapter 1. Rationale and Background

1.1 Management Planning for Mountain Protected Areas

Mountains, by virtue of their clear vertical stratifications of edaphic, climatic, and other environmental factors, are home to an incredible variety of wild biodiversity. Since most of these mountains are isolated both physiographically and climatically, they also harbour a very high endemism of flora and fauna unlike that of oceanic islands. Specifically, the Himalayan Range in the Indian Subcontinent is widely recognized as one of the biodiversity hotspots of the world (Myers et al., 2000). In order to protect this wild heritage, Protected Areas (PAs) comprising Wildlife Sanctuaries and National Parks have been established all along the Indian Himalayas. But mountain PAs have their own peculiar management issues as they support livelihood resources for millions of people living in the mountains. Subsistence farming, livestock grazing, extraction of non-timber forest products, and collection of medicinal plants are some of the major economic activities of mountain communities. Besides, mountains with their cooler climate and challenging landscape attract a large number of summer and adventure tourists. In particular, the Himalayas being the abode of a host of Hindu and Buddhist shrines also draw millions of pilgrims every year. All these factors, despite their conflicts of interest *vis-à-vis* protection of wildlife populations and their habitats, have to be accommodated and adequately addressed to in management plans of mountain PAs.

IUCN World Commission on Protected Areas has stipulated some practical guidelines that could form the basic structure of management plans for mountain PAs (Hamilton & McMillan, 2004). These guidelines specifically address potential management issues that are common to all mountain PAs and can be briefed as follows:

Biological and ecological issues: Mountain ecosystems harbour several species that occur in low density but with wide-ranging movement patterns (e.g. snow leopard). They are also made of unique wildlife habitats that face immediate threats from human interference. Mountains often are the breeding grounds for a large number of migratory animals esp. passerine birds. Integrity of glaciers and mountain streams is vital for the freshwater security of the lowlands and currently the challenge lies in safeguarding them from the impact of global climate change. In this regard, changes in vegetation communities along with the tree-line are to be regularly monitored to study the prognosis of climate change, and mountain PAs are probably the only sites where such monitoring is feasible.

Economic issues: Mountain rivers are frequently dammed to set up hydro-electric projects and they affect the quality of watershed management in the upper reaches and wildlife habitats in downstream PAs. Similarly, development of hard infrastructure like roads, cables, telecommunication towers, and buildings in response to demands from growing tourism industry poses some mitigatory challenges for PA management.

Social issues: Local communities often venerate parts of mountain landscape as sacred and their sentiments need to be given due respect by PA managers. Their traditional knowledge about the flora and fauna should be recognized and documented. Livelihood security of local communities should be weighed before any decision is taken as part of the management plan; for example, human-wildlife conflicts are a major social issue in mountain PAs. Issues of gender disparity, caste discrimination, and cultural differences are to be sorted out before any translocation or rehabilitation plans are implemented.

Legal and institutional issues: Mountain PAs, by virtue of their remoteness and largely inaccessible terrain, are prone to some of the legal inadequacies like absence of clear boundaries, failure to notify the PA status, lack of coordination between different government agencies, and want of clarity on rights of local communities. Sometimes, PA status contradicts provisions of special acts meant to safeguard mountain ecosystems and the people. Identification and organization of local institutions (like *van panchayats*) is generally not followed up in mountain PAs for a participatory approach towards their management. The plans should ensure involvement of all the stakeholders at various levels of planning and implementation.

Political issues: Management plans will be ineffective in the absence of political support and lack of consensus among different stakeholder groups. Hence it is imperative for mountain management plans to be socio-politically more inclusive and accommodative.

1.2 Approach and Components

In recognition of the organizational challenges posed by mountain PAs, it is decided to embrace a more pro-active and prudent approach in developing the current management plan that would also be reflected in the management prescriptions recommended herein. The primary objective is to ensure biodiversity conservation in Rupi Bhaba Wildlife Sanctuary through scientific management. Our approach would be on the basis of the following general guidelines (as adopted from Hamilton & McMillan, 2004):

- Clear and explicit conservation objectives to management plans.

- Different levels of management zones within the PA well-drawn in accordance with the conservation priorities and legitimate needs of local communities for forestry resources, subject to the relevant provisions of the Wild Life (Protection) Act, 1972.
- Greater emphasis on conservation of endemic, restricted-range, and threatened species and ecosystems which are very sensitive to human interference or use.
- A general policy in PAs that favours and promotes natural processes.
- Zero-tolerance for non-native alien species and elimination of any recently introduced species. The goal is to protect the native biodiversity, and NOT to increase species numbers or diversity.
- Recognition in the management plans for mountain PA of the importance of surrounding landscape matrix and connectivity with particular emphasis on wide-ranging and low density species (and their meta-populations).
- Restoration of degraded wildlife habitats and repopulation/restocking of threatened species.
- Sufficient provisions and framework for wildlife population and habitat monitoring protocols in the plan.
- Local communities should derive tangible benefits from the PA, and management plans should identify and set agendas for revenue-generating avenues for people living around PAs. Plans should also build on local and traditional knowledge for management, use, and monitoring of wildlife habitats and populations.
- Conservation education to inform local people, general public, and decision-makers of the PA's biodiversity significance and other important ecosystem services.
- Scientific research as an integral part of the management to evolve evidence-based solutions to problems of PA and to identify keystone species vital for ecosystem functioning.
- Training and capacity building of the PA's staff so that they are better equipped with modern techniques and tools to face the challenges of PA management.

In accordance with these guidelines, the current management plan has been envisaged to have the following components, and specific objectives and prescriptions for each component have been presented appropriately:

Descriptive components: These include the history, geographic area and boundaries, physiography, eco-climatic profile, biogeography, flora and fauna, forest

types and status, socio-economics of local communities, and administrative set-up and infrastructure of the PA.

Prescriptive components: These would essentially deal with the elucidation of problems and recommendations including administrative reforms and restructuring, budgetary projections, measures to improve wildlife habitats, population monitoring protocols, ecotourism initiatives, control of poaching, human-wildlife conflicts, and linkages between conservation and development.

1.3 Background and Preamble

The Rupi Bhaba Wildlife Sanctuary in the Great Himalayan Range of Himachal Pradesh is endowed with a great diversity of land forms from narrow and deep riverine gorges of the Sutlej to steep, precipitous mountains and alpine meadows at higher altitudes. Though this spectacular mountainous landscape is rich in floral and faunal biodiversity, it is one of the lesser-known PAs in the western Himalayas. The Sanctuary holds good populations of mammals like Himalayan Goral, Himalayan Tahr, Himalayan Serow, Musk Deer, Himalayan Black Bear, and Snow Leopard. The rich birdlife includes a greater diversity of avifauna including pheasants (Western Tragopan, Himalayan Monal, Koklass, and Kalij), raptors (Himalayan Griffon Vulture, Lammergeier, Golden Eagle, and Himalayan Buzzard), and other smaller birds like cuckoos, pigeons, woodpeckers, magpies, flycatchers, warblers, thrushes, babblers, sunbirds, and finches.

With a wide elevational range from 2000m to 6000m, vegetation types also change dramatically with respect to altitude, slope, and aspect. The main forest types include moist deodar patches between 2300-2600m, oak-pine forests between 2400-2600m, fir-spruce-blue pine dominant mixed coniferous forests between 2400-3200, maple-horse chestnut-bird cherry dominant moist temperate broadleaved forests between 2300-2800m, and sub-alpine birch-fir forests above 3000m and below tree-line.

Rupi-Bhaba Wildlife Sanctuary is locally well known for its vast and extensive alpine pastures above 3500m, where thousands of livestock are taken for grazing every summer. In particular, Phuphal Ghad and alpine pastures of Upper Bhaba Valley that connect to Pin Valley in the north are notable camping sites for the nomadic shepherds.

The forest-clad mountains with steeper slopes are a general feature of the Sanctuary, and several *nallahs* and streams cut through these gorges draining into four major rivers viz., Rupi, Shorang, Salaring, and Bhaba (Wangar), all tributaries of

the Sutlej River. Each of these river valleys is distinct in its floristics and eco-climatic profile.

Local communities are dependent on the Sanctuary for a variety of forestry resources. Collection of medicinal herbs, particularly dhup (*Jurinea macrocephalla*), karu (*Gentiana kurroo*), mohra or patish (*Aconitum heterophyllum*), and kuth (*Saussurea lappa*) is a major activity. Besides, *gucchi* (*Morchella esculenta*, a commercially valuable fungus grown on forest floor during rainy season) is much sought after by locals.

Rupi Bhaba Wildlife Sanctuary also has a large number of trekking routes and mountain trails most of which are quite challenging and the high mountain-passes connect the Sanctuary to neighbouring parts of Great Himalayan National Park and Pin Valley National Park.

The biological, ecological, socio-economic, and aesthetic values of the Sanctuary make Rupi Bhaba an important PA in the western Himalayas that deserves a comprehensive strategy plan for its holistic management. A strong presence of multiple stakeholders with their largely discordant agendas (as typical of most of the mountain PAs) means that the management plan be more inclusive and imaginative.

1.4 Period of the Management Plan

Though Rupi Bhaba Wildlife Sanctuary was established in 1982, the first management plan was drafted only in 1990 for a ten year period from 1991-92 to 2001-02, with a provision for a mid-term review after five years. The current management plan will be in place for five years between 2010-11 and 2014-15, subject to the final approval by the Chief Wildlife Warden, Himachal Pradesh. This plan may be reviewed after two years by duly assigned competent authority and suitable modifications be incorporated on the basis of the review report.

Chapter 2. Description

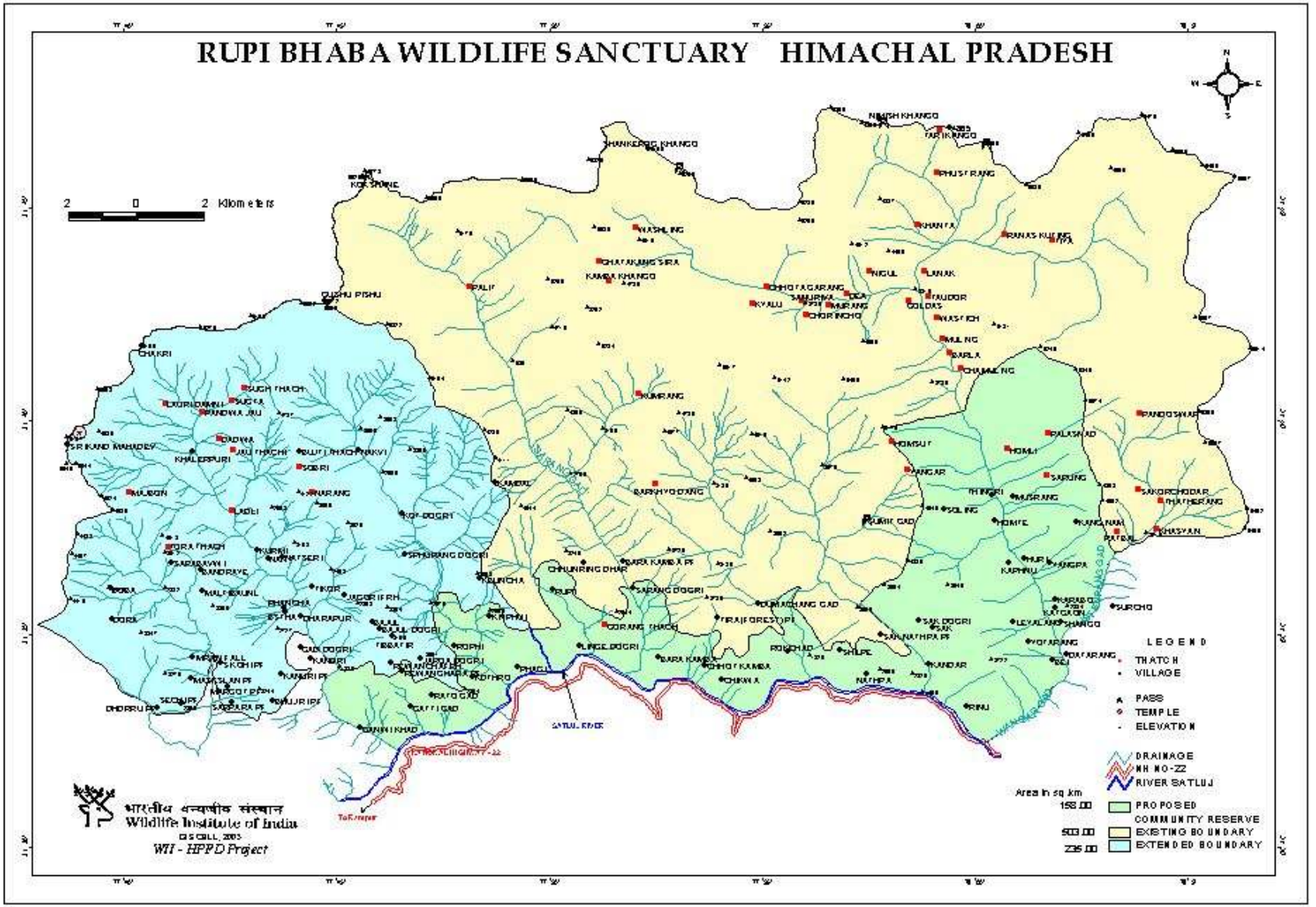
2.1 Area and Location

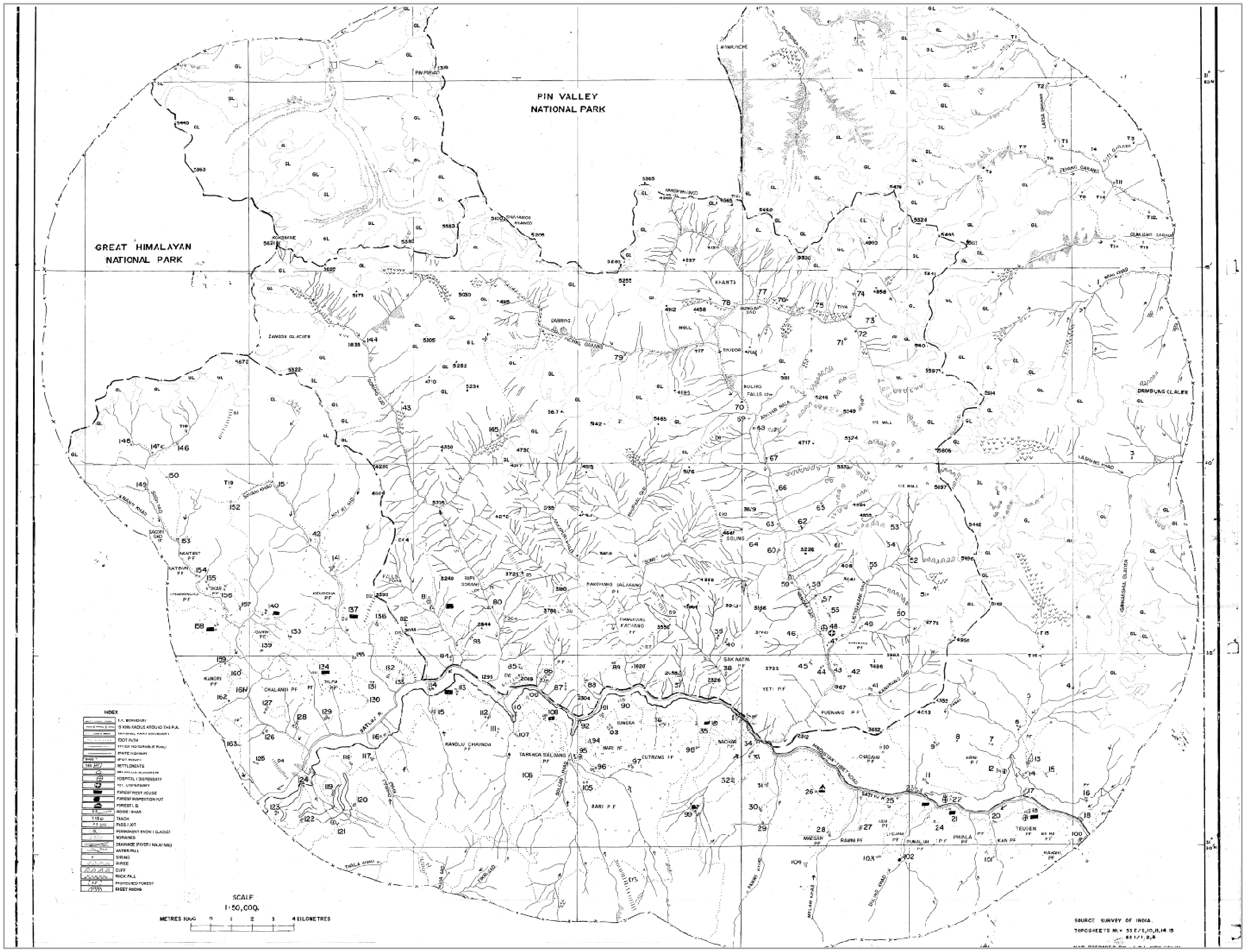
The Rupi Bhaba Wildlife Sanctuary lies in Nichar subdivision of Kinnaur district, Himachal Pradesh along the Upper Sutlej Valley, spreading between 31° 35' and 31° 45' N latitudes and between 77° 49' and 78° 07' E longitudes (Map 1).

Nestled between the Srikhand mountains of the Dhauladhar Range in the west and north and the Sutlej River in the south, the sanctuary covers a total area of 503 sq. km, out of which 269 sq. km. is designated as the core area. The mean elevation of the sanctuary ranges from 2100m and 5900m. The nearest town is Rampur Bushahr (40 km) and the nearest railhead and airport are in Shimla, which is about 200 km away. Rekong Peo (Kalpa), the headquarters of Kinnaur district lies about 40 km on the eastern side of the sanctuary. Rupi Bhaba is accessible through two ways by means of road: i) Shimla to Rampur Bushahr (140 km) on NH-22, then to Chaura (37 km) also by NH-22, at which one has to cross Sutlej River and trek for about 5 km to reach Rupi Valley, OR ii) proceed from Rampur Bushahr along NH-22 beyond Chaura till Wangtu (60 km), cross Sutlej River by Wangtu Bridge and then on to Katgaon (16 km) by road. The sanctuary is under the administrative control of DFO, Sarahan Wildlife Division, Sarahan which is 40 km from Rampur Bushahr. There are two Range Offices, one at Rupi and another at Katgaon.

2.2 Notification

Kinnaur region, formerly part of the princely state of Bushahr, was accorded the status of an independent district in 1960 (Bajpai, 1991). Kinnaur Forest Division from which the current sanctuary was carved out had always been an important source of timber and other forestry resources in pre-independence India since the construction of the old Hindustan-Tibet (HT) road (present day NH-22) in 19th century (Sanan & Swadi, 1998). It has been reorganized twice, in 1984 and subsequently in 1999. The H.P. Govt. notification No. Ft. SC. A (1) 1/83 dated 24.4.1984 bifurcated the erstwhile Kinnaur Forest Division into Nichar and Pooh divisions. In addition, a Wildlife Division was created at Sarahan and the sanctuary areas of the old Kinnaur Division (known earlier as *'pandra-bis*' areas) were transferred to this new Wildlife Division comprising of three wildlife ranges viz., Rupi, Katgaon, and Sangla. However, in another notification (No. FFE-A(A) 1-3/98 –Ft dated 21.12.1999), both the Pooh and Nichar Forest Divisions were merged with a headquarter at Rekong Peo (Kumar, 2000).


RUPI BHABA WILDLIFE SANCTUARY HIMACHAL PRADESH
2 0 2 Kilometers
LEGEND
THATCH
VILLAGE
PASS
TEMPLE
ELEVATION
DRAINAGE
NH NO-22
RIVER SATLUJ
Area in sq.km
158.00 PROPOSED COMMUNITY RESERVE
503.00 EXISTING BOUNDARY
235.00 EXTENDED BOUNDARY
भारतीय वन्यप्राणी संस्थान
Wildlife Institute of India
DISCELL, 2003
WII - HPFD Project


PIN VALLEY
NATIONAL PARK
GREAT HIMALAYAN
NATIONAL PARK
INDEX
SCALE
1:50,000
METRES 1000 0 1 2 3 4 KILOMETRES
SOURCE SURVEY OF INDIA.

The Rupi Bhaba Wildlife Sanctuary was first notified by the Govt. of Himachal Pradesh vide notification number Ft. (F)3-15/81 dated 28th March 1982. It was re-notified for reasons unclear vide notification number Fts. (F)3-15/81 dated 30th June 1982. The Sanctuary was to possess a core area (sanctum sanctorum) free from human habitations and a buffer zone where villages existed. However, the limits of the sanctuary were not exactly spelt out in the original notifications and inclusion of some parts of villages and cultivation in the sanctuary limits posed administrative problems. An exercise was, then, undertaken to realign the limits of core and buffer zones, identify exact boundaries, and to rationalize the geographical extent of the Sanctuary. As a result, a new notification was declared by the Govt. of Himachal Preadesh (vide No. FFEB-F(6) 2/99-II dated 7th September 2001) to re-constitute the Rupi Bhaba Wildlife Sanctuary with memorandum on geographical limits, rights of access to local communities, and the protection status of the area. This had put the total area of the sanctuary at 503 sq. km. with 269 sq. km. area as core (sanctum sanctorum) and remaining under buffer zone where 28 villages are located. In March 2002, an additional area of 235 sq. km. from the adjoining Rampur district was added to the core of the sanctuary, making the total area as 738 sq. km. However, this notification was subsequently withdrawn in view of administrative problems it posed.

2.3 Boundaries

North: Main range of Srikhand Dhar starting from Kokshane Peak - 5773m (31° 45' 33" N and 77° 50' 12" E) passing through high points - 5695m, 5530m, 5100m, 5205m, 5288m, 5365m, 4865m, and up to 5567m (31° 45' 39" N and 78° 06' 46" E).

South: From peak 5496m (31° 37' 34" N and 78° 07' 06" E) along the ridge descending down to Listigarang Gad south of Khasyan to meet the Listigarang Gad at 3214m, and then along the stream till below Ratba, from where the boundary follows up the ridge of Angyar dhar passing through points 4692m, 4853m, 5574m, and 5349m up to 5246m. Then along the ridge till beginning of the Angyar Nala just short of Mulling down the Angyar Nala to Wanger Khad (Bhaba River) and then across the river to the ridge on the right side up to the point at 5176m. From there along the ridge of Soling dhar to point 4645m along the ridge to 4336m, 3964m, then up to 3550m and then turning east along the Kandhar Beat up to lower outer boundary of Sak Nathpa PF. From there turning west along lower outer boundary of Sak Natpa PF excluding Shilpe cultivation and further along outer boundary of Dangarang PF, Rakchang, Salaring PF, Tiya PF, Chhota Kamba PF, Bara Kamba PF, then down to Shorang Khad up to the source of Bara Kamba kuhl. Thereafter the boundary follows the forest footpath up to Rupi FRH excluding the cultivation of Rupi Village and up to

the boundary of Kinnaur and Shimla districts on Srikhand Dhar at point 3038m (31° 35' 31" N and 77° 49' 51" E).

East: From high point 5567m (31° 45' 39" N and 78° 06' 46" E) on the main Srikhand mountain range heading south dividing first Nichar from Moorang Tehsil then Kalpa Tehsil till the point on the ridgeline of the Mukim Dhar up to peak 5496m (31° 37' 34" N and 78° 07' 06" E).

West: Starting from the high point 3038m (31° 35' 31" N and 77° 49' 51" E) along the boundary with Shimla district to Srikhand Dhar via Ghishu Pishu Peak at 5672m up to Kokshane Peak 5773m (31° 45' 33" N and 77° 50' 12" E).

2.4 Physiography

The sanctuary is primarily mountainous with steep precipitous peaks characterizing the landscape. There are innumerable rivers, streams, and *nallas* draining these narrow mountain valleys and gorges and they serve an important watershed and catchment for the Sutlej River. Four main tributaries *viz*., Rupi, Shorang, Salaring, and Wangar (Bhaba) that run from north to south draining into Sutlej River form the four main valleys of the sanctuary from west to east. Each of these tributaries has its own network of drainage like Lankapuri and Phuphal Gad of Salaring and Listigarang of Wangar Gad. Each river valley is also characterized by distinct eco-climatic and floristic profile; for example, Rupi and Shorang valleys support large tracts of temperate mixed coniferous forests and oak-dominant forests, while Bhaba valley is predominantly temperate conifers and alpine vegetation. Most of the human habitations are villages that dot the left and right banks of the Sutlej River with all the interior river valleys are virtually uninhabited except for nomadic shepherd camps in summer.

There are more than 15 peaks within Rupi-Bhaba which are over 5000m in altitude. Some of the highest peaks of the sanctuary include Chikim Dhar (5914m), Pandoshwar (5806m), and Mulling Rag (5465m). The crests of these mountain peaks generally lay in perpetual snow interspersed with some of the spectacular glaciers of the Western Himalayas.

Along the northern boundary, there are three high mountain passes v*iz*., Shakarog Khango (5100m), Nimish Khango (4890m), and Tari Khango (4865m), all of which connect Rupi Bhaba with the Pin Valley National Park of the Lahul and Spiti district. A fourth pass, Kamba Khango (4785m) lies well within the sanctuary area connecting Shorang and Bhaba Valleys. These mountain passes are covered in deep

snow for most parts of the year and open for movement of trekkers and shepherds only for a short period between June and September.

2.5 Geomorphology

The known geological formations in the region are as follows (Kumar, 2000):

Pre-Cambrian	: Schists, gneisses, granites, and quartzites
Late Pre-Cambrian	: Phyllites, quartzites, conglomerates, shales, and slates
Silurian	: Coral limestone, and quartzites
Carboniferous	: Quartzites and limestone
Triassic	: Limestone, shale, and dolomite
Recent/Sub-recent	: Soils

The important rock formations in the forest areas are gneisses, schist, phyllites, quartzites, and granites. Among the members of the schistose series micaceous schists, talcose rocks, phyllites, and gneisses are commonest and support good forests of deodar, kail, and fir in Nichar Range. In the wangar Gad, there is an outcrop of greenish quartzite which rapidly assumes a gneissic structure. Extensive outcrops of 'granitoid gneiss' are seen beyond Wangtu along NH-22. This rock type is geologically termed as 'Wangtu gneiss' which supports medium quality kail.

Schists and soft-banded gneiss, which decompose more rapidly, tend to produce deeper soils than the hard fine-grained gneiss and quartzite. The soils produced by the former vary from clay to clay-loam and are often heavy and retentive of moisture to a considerable degree, edaphic conditions favoured by kail and silver fir. Fine-grained gneiss produce well drained sandy loam when decomposition is slow, but coarse gritty sand when decomposition is rapid. The former is particularly preferred by finest deodar growth.

Depth and fertility of soil are both dependent on the presence of sufficient humus. Under a fir or broadleaved canopy, the quantity of humus produced is greater than that under a deodar. Spruce canopy is sufficient to produce a fertile loam.

The soil profiles are generally well developed in higher locations under dense forest, but lower down they suffer from erosion and offer less scope for developing. Soils in most of the areas are formed in situ and are more or less loamy to clay-loam. Generally speaking, the soil is shallow on ridges, spurs, and precipitous slopes. On the other hand, it is moderately deep on the cooler aspects and gentle slopes. On steep slopes, the soil is rapidly eroded by precipitation particularly where it lies just above sheet rock, unless it is adequately protected by woody vegetative growth. Owing to

the very steep inclination of the terrain in Rupi Bhaba Sanctuary, soils are generally shallow. With steeply inclined rock strata and unstable surface soils, it is not uncommon to find boulder beds and detritus deposits at the base of the ridges in the sanctuary.

The chemical constitution of soils does not appear to have so important bearing on the quality of tree growth as do their physical properties. Preservation of tree growth on hot aspects and steep slopes is strongly recommended as a means of preserving soil fertility and a guard against soil erosion in Rupi Bhaba where natural forces often become calamitous.

2.6 Climate

The climate in Rupi Bhaba Sanctuary is predominantly temperate with a more subtropical environment along the lower reaches. However, with such a wide elevational range (2100-5900 m), inter-annual and intra-seasonal climatic variations are markedly higher in the region. The northern parts of the sanctuary, most of which are above 4000m altitude are under perpetual snow with tundra-like climate. There are four clearly defined seasons that mark the region's local climate: spring, summer or monsoon, autumn, and winter.

The spring extends from mid March to mid June and is characterized by a sunny weather in the forenoon and moderate to heavy showers in the afternoons.

The summer season, from mid June to mid September, is the hottest period when both day temperature and relative humidity are highest. Intense heat is generally experienced along the main Sutlej Valley because of large bare rocky mountains that overlook the river bank. Interior valleys however are relatively cooler in summer owing to dense moist temperate vegetation on slopes. By the end of June, south west monsoon breaks bringing in copious rainfall along the outer Himalayas, but less so in the interior valleys.

The autumn season that immediately follows the monsoon between mid September and mid November is probably the driest period when there is very little rain or snow and diurnal range of temperature is quite marked. Areas above 2000m altitude experience frost during this period.

The winter lasts from mid-December up to mid-March and even till April in alpine localities in the north. It is characterized by heavy frost in the lower areas and fairly heavy snowfall at higher elevations. Snow may descend down to Sutlej valley (1500m) during severe spells, but does not usually stay longer below 2000 m.

Similarly, the accumulation of snow is often high in the forest belt but quickly melts away on south-facing slopes. By the end of April, all but high-lying forests and deep interior valleys on the northern aspects are cleared of snow.

The climate of the Sutlej Valley shows a gradient of moisture from outer Himalayas with their heavy monsoon to the arid cold alpine areas where heavy snowfall in winter and practically no summer rains occur. The monsoon clouds advancing from the plains of India are combed out by the outer ranges of the hills, where most of the monsoon rains fall, so that the inner valleys get a good deal of clouds but no steady precipitation. The snowfall is also heavier in the Himalayas than it is on the neighbouring Tibetan Plateau.

The temperature also varies according to the elevation. Temperature begins to rise rapidly from April onwards till June, which is the warmest month. It remains more or less high between June and September after which it starts to drop. Then the temperature becomes very low with the onset of winter, and January is the coldest month (Table 1). In association with the passage of western disturbances in the cold season, the sanctuary area experiences severe cold spells when the temperature often goes down below the freezing point. Frost is also very common between October and May.

Table 1. The meteorological records of weather observatory located at the Wildlife Complex, Sarahan Bushahr during 1989.

Month/Year	Dry bulb temperature (°C)		Wet bulb temperature (°C)		Rainfall (mm)
	Maximum	Minimum	Maximum	Minimum	
Jan-89	11.6	1.0	9.5	1.0	134.6
Feb-89	12.0	2.0	14.5	2.0	147.8
Mar-89	13.0	1.0	7.0	1.5	100.0
Apr-89	17.5	8.0	14.0	3.0	28.0
May-89	28.0	9.5	28.0	6.5	31.2
Jun-89	26.0	15.0	27.0	14.0	37.9
Jul-89	24.0	14.0	24.5	13.5	238.8
Aug-89	22.5	14.5	22.0	13.0	269.5
Sep-89	20.5	13.0	17.5	10.5	50.6
Oct-89	19.0	8.0	19.5	8.0	7.1
Nov-89	12.0	2.5	12.5	3.0	40.8
Dec-89	11.6	1.0	11.5	-2.0	204.8

2.7 Water Availability and Drainage

Sutlej is the principal river that forms the southern boundary of the Sanctuary. It is fed by several smaller rivers and streams that cut through the sanctuary among which the following four form the major tributaries:

1. Rupi

Tikada Gad

2. Shorang

Kumrang Gad

3. Salaring

Khorang Gad (Chikap Gad)

Lankapuri Gad

Phupal Gad

Sumit Gad

4. Wanger (Bhaba)

Listigarang Gad

Kundru Khad

Most of the khads or gads (*nallahs*) are perennial fed by melting snow and rains. There are also several hot springs in the region. One popular hot spring is located at the village Natpa, 5 km from Nichar and another at Tapri outside the Sanctuary. The year-long availability of water coupled with steep rocky gorges has made Sutlej a focal point of several hydro-electric projects that are being developed all along the Sutlej River and lower reaches of its tributaries like Salaring and Wanger Gad.

2.8 Biogeography

As Rupi Bhaba Wildlife Sanctuary geographically abuts the Great Himalayan National Park on the west that represents the Greater Himalayas and the Pin Valley National Park on the north signifying the Trans-Himalayan landscape, the natural vegetation and associated faunal elements also reflect this diversity from west to east and from south to north. Biogeographically, the Sutlej Valley signifies the change from north-west Himalaya to western Himalaya. This transition is also reflected in the ambiguity with which Rupi Bhaba is usually treated in the biogeographical classification scheme of Rodgers and Panwar (1988). Though the Province of North-west Himalaya extends up to Sutlej Gorge in the west (after which the limits of the Province of Western Himalaya starts), Rupi Bhaba which lies west of the Sutlej Gorge was originally classified under the Province 2B (Western Himalaya). However, it was

re-classified under 2A (North-west Himalaya) in the revised edition of the biogeographic classification (Rodgers et al., 2002). An important distinction between these two biogeographic provinces is shown by the eco-climatic conditions and faunal elements; for example, species like Asiatic Ibex and Western Tragopan are among the flagship species of the North-west Himalaya. In view of these considerations, inclusion of Rupi Bhaba under the North-west Himalayan Province (along with the Great Himalayan National Park) is justified though presence of Asiatic Ibex in Rupi Bhaba remains hypothetical, yet very much possible in areas adjacent to Pin Valley National Park. As the Sanctuary lies at the junction of two biogeographic Zones (Himalaya and Trans-Himalaya) and three biogeographic Provinces (Ladakh, North-west and Western Himalaya), it represents biologically significant transitions in floristic and faunal composition (Jishtu et al., 2007).

The biogeographical uniqueness of the Himachal avifauna has already been commented upon by Price et al (2003) who compared the avifaunal composition of Manali in Himachal Pradesh and Overa in Jammu & Kashmir. In this respect, the birds of Rupi-Bhaba also show some of the peculiarities of avifaunal distribution across Western Himalayas. Sutlej Valley with its deep ravines and mountain gorges acts as a biogeographical barrier for dispersal of flora and fauna between east and west; at the same time, it also serves as an important pathway for dispersal and migration of taxa from the Palearctic Tibetan Plateau to Indian Subcontinent. For example, we observed quite a few numbers of migratory birds like Hume's Leaf-warbler, Tickell's Warbler, Fire-fronted Serin, and Common Rosefinch evidently moving up along the Sutlej Valley in our survey. In fact, one of the Indian Subcontinent's rarest birds, the Large-billed Reed Warbler (*Acrocephalus orinus*) was first described from one specimen collected from Sutlej Valley near Rampur in 1867; the species was never found again till its recent rediscovery in Thailand in 2006 after a gap of 139 years (Round et al., 2007). It seems that this species must be regularly using the Sutlej Valley as a migratory flyway, as more wintering records are being currently made in the Indian Subcontinent.

Rupi Bhaba Wildlife Sanctuary, thus, assumes a greater conservation significance given the biogeographical transition mediated through the region.

2.9 Flora

Rupi Bhaba Wildlife Sanctuary supports a great diversity of vegetation types including moist temperate oak-pine forest, western mixed coniferous forest, sub-alpine birch forest, and alpine meadows and pastures. In total, 17 kinds of forest

associations belonging to six vegetation types (as per classification by Champion and Seth, 1968) are to be found in the sanctuary. Please refer to Chapter 3 for detailed accounts of each of these forest types. A recent floristic survey of the sanctuary has recorded 635 species of plants belonging to 247 genera in 103 families (Jishtu, 2007). Among the plant families, Asteraceae and Rosaceae are the most dominant, followed by Ranunculaceae, Brassicaceae, Fabaceae, Apiaceae, Lamiaceae, Polygonaceae, Liliaceae, Poaceae, and Cyperaceae. Among the plant genera, species-rich ones include *Berberis*, *Thalictrum*, *Impatiens*, *Acer*, *Potentilla*, *Prunus*, *Rubus*, *Lonicera*, *Artemesia*, *Aster*, *Saussurea*, *Primula*, *Quercus*, *Salix*, *Juncus*, and *Carex*.

Some of the dominant and characteristic temperate woody plants are listed in the following table (Table 2) along with the altitudinal limits of their distribution in Rupi Bhaba Sanctuary (after Jishtu, 2007).

Table 2. Characteristic woody plants of Rupi Bhaba Wildlife Sanctuary along with their altitudinal limits of distribution.

Scientific name	**Local/common name**	**Elevation range**
Pinus roxburghii	Chir pine	1400-2300 m
Pinus wallichiana	Blue pine, kail	2100-3000 m
Abies pindrow	Silver fir, tosh, sapan	2100-3300 m
Abies spectabilis	Silver fir, tosh, sapan	2800-3600 m
Cedrus deodara	Deodar	1800-3000 m
Picea smithiana	Spruce, rai	2100-3600 m
Taxus baccata	Common yew, rakhal, nyamdal	2100-3200 m
Quercus leucotrichophora	Ban oak	1200-2400 m
Quercus glauca	Bani oak	1500-2500 m
Quercus floribunda	Moru oak	1800-2700 m
Quercus semecarpifolia	Kharsu oak	2100-3500 m
Alnus nitida	Alder, kunees, kosh	1200-2700 m
Betula alnoides	Kathbhoj	1500-2700 m
Betula utilis	Birch, bhoj	2700-3800 m
Juglans regia	Walnut, akhrot	1500-3000 m
Ulmus wallichiana	Him. elm, maldung	1800-3000 m
Symplocos paniculata	Lodh	2000-3000 m
Prunus cerasoides	Panja	1500-2400 m
Prunus armeniaca	Chuli	1500-2500 m
Prunus persica	Reg, baimi	1800-3300 m
Prunus cornuta	Him.bird-cherry, jamun	2100-3500 m
Pyrus pashia	Shagal	1400-2700 m
Acer acuminatum	Manderang, unn	1800-3000 m
Acer caesium	Him. maple, chirandru, manderang	2000-3000 m
Acer sterculiaceum	Unn, kanjal	2000-3000 m
Acer cappadocicum	Unn, kanjal	2500-3000 m
Aesculus indica	Him. horse chestnut, jungli khanor	1800-2800 m
Rhododendron arboreum	Baras	2200-3000 m
Rhododendron campanulatum	Shyargal	2800-3800 m

The sub-alpine and alpine regions are richer in medicinal and aromatic plants, which are commercially exploited. Prominent among them are jungli jeera (*Carum*

corvi), bankakri (*Podophyllum hexandrum*), tallish patra (*Rhododendron anthopogon*), karu (*Picrorhiza kurrooa*), dhoop (*Jurinea macrocephala*), hath-panja (*Dactylorhiza hatagirea*), chukhli (*Rheum australe*), patish (*Aconitum heterophyllum*), *Saussurea obvallata*, and gandrayan (*Angelica glauca*). In view of the great diversity of medicinal plants in the Sanctuary, Rupi Bhaba has been designated as an IPA (Important Plant Area) for medicinal plants [IPA-7/WIH].

The higher reaches of Rupi Bhaba Sanctuary in the north are characterized by extensive spread of alpine pastures and meadows, used as traditional grazing grounds by nomadic shepherds every summer. These also serve as important habitats for key wildlife species like Musk Deer, Bharal, and Brown Bear. It has been estimated that over 30 % of the sanctuary's core area is covered under these pastures. See Table 3 for a list of major alpine pastures and meadows in Rupi Bhaba Sanctuary.

Table 3. List of major alpine pastures and meadows in Rupi Bhaba Wildlife Sanctuary.

Sl. No.	Catchment	Name of pastures
1.	Wanger (Bhaba)	Chundia, Choi, Chorangang, Chotagarang, Dalering, Dea, Dulmanka, Goldas, Gyare, Humset, Jaktoyachul, Kangarang, Kanguman, Kara, Khak, Khasoling, Khasyari, Lanak, Mulling, Mustang, Namayachul, Nigul, Padal Thatch, Palasnud, Pandoswar, Posha, Rana Shaktung, Ratpordi, Rhustirang, Sakkanda, Selti, Sokacho Dhar, Solrang, Talung, Tander, Thotaring, Tisyo, Waja Thacharang, Wastich, & Yanger
2.	Salaring	Choring Cho, Dea, Kyalan, Phupal, & Washling
3.	Shorang	Barkhayo, Dampal, Dumti, Kumrang, Palit, & Skamdal

2.10 Fauna

The wild fauna of Rupi Bhaba Sanctuary were poorly documented with no previous wildlife studies in the region barring a few rapid surveys conducted as part of management plans. These surveys also focused on higher forms like mammals and birds. In particular, invertebrates and lesser vertebrates of the sanctuary remain virtually unknown. We undertook a recent faunal survey between April-June, 2008 to collect primary data on status and distribution of mammals, birds, and herpetofauna.

As Rupi Bhaba lies in the junction of three biogeographical provinces, it has exceptional diversity of faunal elements. In total, 65 species of mammals are known to exist in the sanctuary (Refer to Appendix 10, for a list of mammals of Rupi Bhaba Wildlife Sanctuary). However, mammal populations are generally low in density, barring a few species like Serow and Common Leopard. Heavy disturbance owing to movement of shepherds and mushroom collectors, habitat degradation due to overgrazing by livestock, and poaching (which was rampant till recently) are the

primary causes. Mammal diversity of Rupi-Bhaba is generally dominated by taxa typical of Palaearctic realm like mountain ungulates, brown bears, high-altitude felids, mustelids, and pikas. The buffer zone of the sanctuary along the main Sutlej Valley is characterized by mammals of outer Himalaya and Shiwalik Range like Goral, Large Indian Civet, Indian Crested Porcupine, and Indian Hare. The following table (Table 4) summarizes the mammal diversity of the sanctuary.

Table 4. A summary of mammal diversity of Rupi Bhaba Wildlife Sanctuary.

Mammal taxa	**No. of species**	**Notable species**
Insectivores	6	Himalayan Water Shrew & Horsefield's Shrew
Bats	12	Greater Horseshoe Bat & Hutton's Tube-nosed Bat
Primates	2	Rhesus Macaque & Common Langur
Felids	4	Leopard Cat, Common Leopard, & Snow Leopard
Viverrids	3	Large Indian Civet & Himalayan Palm Civet
Herpestids	1	Common Indian Mongoose
Mustelids	7	Yellow-throated Marten, Stone Marten, Himalayan Weasel, & Yellow-bellied Weasel
Canids	2	Red Fox
Bears	2	Asiatic Black Bear & Himalayan Brown Bear
Ungulates	7	Himalayan Musk Deer, Goral, Serow, Himalayan Tahr, Asiatic Ibex, & Blue Sheep
Rodents	16	Red Giant Flying Squirrel, Royle's Mountain Vole, Turkestan Rat, White-bellied Rat, & Indian Crested Porcupine
Lagomorphs	3	Indian hare, Royle's Pika, & Large-eared Pika

Though Rupi-Bhaba WLS has a wide elevational range from 2100 to 6000m and represented by both Great Himalayan and Trans-Himalayan ranges, its birdlife (with a little over 200 species) is not as exceptionally rich as either GHNP in the west or the Garhwal Himalayas in the east [See Appendix 8, for a provisional list of the birds of Rupi-Bhaba WLS]. The major factor is the predominance of dry temperate coniferous forests which support very few bird species and patchy distribution of temperate broadleaved vegetation including oak- rhododendron mixed forest which is known to harbour high species diversity of birds in the Western Himalayas. Nonetheless, Rupi-Bhaba holds significant populations of bird taxa that primarily inhabit dry temperate mixed coniferous forests; these include Western Tragopan, Koklass, Spotted Nutcracker, Spot-winged Tit, *Phylloscopus* leaf warblers, White-cheeked Nuthatch, Bar-tailed Treecreeper, Mistle Thrush, and Black-and-yellow Grosbeak. This also explains why some of the common birds of Western Himalays like hill-partridges, hawk-cuckoos, jays, laughingthrushes, sibias, and sunbirds are either rare or locally absent in Rupi-Bhaba. The Sanctuary is generally richer in some avian taxa including pheasants, raptors, owls, swifts, warblers, thrushes, flycatchers, and

finches. Presence of habitat-specialists like Eurasian Woodcock, Wood Snipe, and Solitary Snipe which breed in high-altitude marshes and alpine meadows further underscores the importance of Rupi-Bhaba WLS for conservation of Himalayan avifauna. The following Table 5 summarizes the bird diversity of the sanctuary.

Table 5. Summary of the avian diversity of Rupi Bhaba Wildlife Sanctuary.

Major avian taxa	No. of species	Notable species
Pheasants	9	Himalayan Snowcock, Western Tragopan, Koklass, Himalayan Monal, Cheer, & Kalij Pheasant
Raptors	16	Eurasian Hobby, Lammergeier, Himalayan Griffon Vulture, Himalayan Buzzard, Golden Eagle, & Booted Eagle
Snipes	3	Eurasian Woodcock, Solitary Snipe, & Wood Snipe
Pigeons & doves	5	Snow Pigeon, Speckled Wood Pigeon, & Wedge-tailed Green Pigeon
Owls	6	Mountain Scops Owl, Himalayan Wood Owl, & Collared Owlet
Swifts	5	Himalayan Swiftlet, White-throated Needletail, & Fork-tailed Swift
Woodpeckers	4	Speckled Piculet & Himalayan Pied Woodpecker
Corvids	8	Blue Magpies, Spotted Nutcracker, & Choughs
Tits	6	Spot-winged Tit, Green-backed Tit, & White-throated Tit
Warblers	16	Brownish-flanked Bush Warbler, Large-billed Reed Warbler, Lemon-rumped Warbler, Hume's Warbler, Large-billed Leaf Warbler, Western Crowned Warbler, & Grey-hooded Warbler, & Whistler's Warbler
Laughingthrushes	5	Striated Laughingthrush, Streaked Laughingthrush, & Variegated Laughingthrush
Thrushes	11	Blue Whistling Thrush, Long-billed Thrush, Mistle Thrush, & Grey-winged Blackbird
Chats & robins	18	White-tailed Rubythroat, Indian Blue Robin, White-browed Bush Robin, Blue-capped Redstart, Blue-fronted Redstart, & Spotted Forktail
Flycatchers	10	Dark-sided Flycatcher, Rusty-tailed Flycatcher, Ultramarine Flycatcher, Slaty-blue Flycatcher, & Grey-headed Canary Flycatcher
Wagtails & pipits	6	Grey Wagtail, Olive-backed Pipit, & Rosy Pipit
Finches	17	Fire-fronted Serin, Yellow-breasted Greenfinch, Plain Mountain Finch, Pink-browed Rosefinch, Red-headed Bullfinch, Black-and-yellow Grosbeak, & Spot-winged Grosbeak
Buntings	3	Rock Bunting & Chestnut-eared Bunting

The herpetofaunal diversity of the Western Himalaya is generally low and unremarkable owing to the unfavourable microclimate prevailing in the high-altitude mountains for these cold-blooded creatures and extreme remoteness of the region. Our short survey revealed the presence of three species of amphibians (including Himalayan Toad, Beautiful Torrent Frog, and Stoliczka's Frog) and five species of

reptiles (viz., Kashmir Rock Agama, Himalayan Ground Skink, Ice Field Skink, Himalayan Keelback, & Himalayan Pit Viper). However, further intensive and systematic surveys should be conducted to make a complete inventory of the herpetofauna of the sanctuary.

2.11 Socioeconomics

There are 28 villages in the buffer zone of the notified sanctuary area with a human population of 6371 (1991 census) and cattle population of 14,257. The local communities are by and large agrarian (with a total cultivation area of 807 ha) and a few young generation members are currently working outside either in government services or unorganized labour sector. Though cultivation of wheat, rice, and potato is the traditional practice, local people have started to grow apple, walnut, pear, and other commercially viable crops. Animal husbandry (esp. rearing of sheep and goats) has been practiced by the local communities as a source of supplementary income.

Till recent past, extraction of non-timber forest products used to be a major vocation of the locals. But this practice has since been on the decline owing to their diminishing economic returns and opening up of more lucrative market-economy. However, collection of 'guchchi' a fungus grown on damp forest floor during rains still remains a major activity as it fetches huge price in the markets.

In the past, poaching of wildlife was apparently common, as hunting was a prime pastime of the locals. In particular, Musk Deer was poached extensively for the commercially valuable musk-pod (an abdominal gland in male animals) which would then be sold in markets of Rampur Bushahr, Shimla, Amritsar, and Ambala. Barking Deer was heavily killed for its meat and even today the Barking Deer population in the Sanctuary is very low. Himalayan Tahr and Goral were other animals which were hunted in a large scale for meat. Himalayan Monals were trapped and killed for their crest feathers which the villagers used to wear on their caps as a status symbol. Fortunately, poaching became much reduced since the enactment of the Wild Life (Protection) Act, 1972 and the re-notification of the Sanctuary status in 2001. Moreover, establishment of several hydel projects (pioneered by the Sanjay Vidyut Pariyojana & Nathpa-Jhakri Hydel Project) along Sutlej and its tributaries in recent years has opened up employment opportunities among the locals and this has, to a certain extent, weaned away the locals from poaching practices.

Traditionally, people in Kinnaur are granted, by the Bushahr State Settlement 1921, three forest rights *viz*., livestock grazing, timber for construction of buildings (TD), and lopping of conifers and other temperate trees for fodder. However,

overexploitation of forestry resources led the government to impose certain regulations and restrictions on these rights in recent years. By this, it is mandated that one should get license, on a case-to-case basis, from the respective Range Office to graze cattle or to obtain timber. This has caused some resentment among the public and there is a growing demand particularly for removal of restrictions on timber rights as houses in Kinnaur are traditionally built with wood to withstand cold in winter.

In general, people in Bhaba valley are relatively well off as a result of recent commercialization of the valley in response to establishment of hydel projects which were followed by huge infrastructural development like roads, buildings, electricity, telecommunication, and residential colonies. In contrast, people in Rupi, Shorang, and Salaring valleys continue to remain poor as these areas lack even basic amenities like road network.

2.12 History of the Forests and Forestry Administration

Rupi Bhaba Sanctuary was historically a part of the Kinnaur Forest Division under the control of the Bushahr State. There is no reliable record of the history of these forests prior to 1850. The past history can be divided into five periods i.e., 1850-1891, 1892-1904, 1905-1930, 1931-1960, and 1961-1976 (after Kumar, 2000).

Period-I (1850-1891):

In 1850, an Indian trader purchased deodar trees from the Rajah of Rampur Bushahr State at the rate of 2 annas (12 paise each). But the forests were not heavily felled until 1859 when other traders obtained permits to fell an indefinite number of trees by payment of money to the King. In 1862, Mr. Cleghorn, while on an inspection visit remarked about the sheer wasteful working of forests by the timber traders. It was estimated that in some cases not more than 10% of the logs reached the plains. On Cleghorn's suggestion, the Rajah requested the Superintendent of Hill States to appoint an officer for exercising control over the working of forests and for realization of revenue which was proposed at Rs. 3.50 per deodar tree.

As a first step, Mr. Barnes, the Superintendent of Hill States, drew up rules for the management of these forests and a native Forest Ranger was appointed, but these measures did not have the desired effect.

In 1864, the management of the Bushahr State forests was taken over by the British Government and lease was concluded with the Raja of Bushahr in consideration of certain payments. In the same year, Brandis made an inspection tour

in the Sutlej Valley and he reported that 30,000 deodar trees had been felled between 1859 and 1863. Brandis drew up a felling scheme by which fellings were allowed only in the easily accessible forests on the left bank of the Sutlej and fellings limited to trees of girth less than six feet; the number of fellings was also limited to 3000 trees annually. In 1872, when Brandis visited Bushahr again, he found that the average felling rate was only 1400 trees. He recommended early preparation of a proper working plan.

In 1874, Ribbentrop along with Batchelor and Stenhouse started preparing the first regular working plan for the forests of the Bushahr State. The plan was for the period 1875-1880. The plan was of particular interest because it recognized the differences between the treatment of compact blocks of regular high forests and that of irregular forests on steep ground. The plan also did a detailed examination of the Pandrabis forests (which became Rupi Bhaba Sanctuary later).The growing stock of deodar exclusive to Pandrabis forests was estimated to be 98,000 class-I trees and the annual yield was fixed at 2000 class-I trees. Between 1875 and 1880, only 3309 trees were felled, but during the ten years ending 1891 the annual average felling amounted to 2302 deodar trees.

In an inspection note of 1885, Miniken observed that natural regeneration of deodar could be obtained without opening the canopy at all and it was undesirable to make any fellings until regeneration had come in. There are no authentic records to show if any artificial regeneration was attempted and with what results. It is, however, mentioned that a small bouldry patch of about 4 ha. near Sholtu on the left bank of the Sutlej of which a few trees still exist.

The earliest attempts to demarcate the forests were made in 1868. In the first instance, only deodar forests were demarcated under working plan. By 1887, Manikin completed the settlement and demarcation but owing to certain discrepancies, it was not adopted. In 1916, Glower took up the work again and finally completed it in 1921. The Survey of India completed a special forest survey of the tract in 1886-87 which facilitated the overall management of the forests.

Period-II (1892-1904) [Lace's Plan]:

Lace's plan was the first detailed plan prepared for the Sutlej forests. Recognizing that deodar tends to form compact blocks of even-aged forest, successive regeneration fellings were prescribed for forests workable under the system. The interval between successive fellings varied from 10 to 20 years. Under this plan, kail was treated as a weed with extensive thinning. This practice was rightly discarded in 1900 by Elliot and by Hart in his plan.

Period-III (1905-1930) [Hart's Plan]:

Under Hart's Plan, forests were divided into five working circles, out of which three were in Kinnaur: Kanawar Working Circle, Sugnam Working Circle, and Sutlej Working Circle under which the present Rupi Bhaba Sanctuary was covered. The Sutlej Working Circle was again subdivided into 6 felling series coterminous with the forest ranges, five of which lay in Kinnaur. The shelterwood fellings prescribed under this plan produced excellent results. However, it was shown that expensive removal of the overwood resulted in a heavy influx of weed. The vital principle of shelterwood fellings in the dry zone to afford protection against the sun was enunciated and generally accepted. The programme of thinnings and improvement fellings prescribed in the plan was fully carried out. But, there had been a tendency to fell kail ruthlessly in thinnings in favour of even suppressed deodar. Thinnings of both deodar and kail have been rather heavy in the dry zone forests.

Period-IV (1930-60) [Hamilton's Plan]:

Hamilton revised hart's Working Plan for the Kanawar tract of the Upper Bushahr Division, now Kinnaur Forest Division. Hamilton recognized the great value of Kinnaur forests for the welfare of the people in the plains and preservation of forest cover was considered as the basic objective of management. Five Working Circles were constituted and the present Rupi Bhaba Wildlife Sanctuary was covered in the Wet Zone Selection Working Circle. The exploitable diameter for both deodar and kail was fixed at 30" (75 cm) dbh. The felling rules were prescribed in great details. Removal of class-IB trees were recommended in preference to class-IA trees for sustainable yields. Shelterwood fellings were prescribed on patches of mature forest on easy ground and around the existing advance growth. The main provisions of Hamilton's Plan were largely completed.

Period-V (1961-76) [Tandon's Plan]:

Tandon also placed the present sanctuary of Rupi Bhaba under the Wet Zone Selection Working Circle. He remarked that the forests were generally understocked owing to overexploitation with the regeneration and first class trees being generally in short supply. Fir and spruce forests were largely over-mature with highly deficient regeneration. These forests have been exploited during 1940s and 1950s and have not responded to any regeneration efforts. Being situated on steep and precipitous terrain, these forests are less workable under a system of concentrated regeneration felling. Hence, a modified selection system called Punjab Selection System was prescribed. Natural regeneration was to be aided by artificial reproduction in well-defined blocks. The exploitable diameter was revised to be 24" (60 cm) dbh. A felling

cycle of 15 years corresponding to the period of Working Plan was fixed. There are extensive undemarcated forests covered under Tandon's Plan.

Recent period:

The management of wildlife in *Pandra-bis* forests (present-day Rupi Bhaba Sanctuary) was entrusted with DFO, Nichar up to 1984. However, the forests were under the territorial working plan circles as recounted above. Subsequent to its first notification as Wildlife Sanctuary in 1982, the management of the entire area along with the forests and wildlife was transferred to DFO, Sarahan Wildlife Division in 1987.

2.13 Management

2.13.1 Administration and Staff Structure

The Rupi Bhaba Wildlife Sanctuary is under the direct administrative control of the DFO (Wildlife), Sarahan Wildlife Division, Sarahan which, in turn, falls under the jurisdiction of the Conservator of Forests, Shimla Forest Circle. The Sanctuary is divided into two Forest Ranges each of which is again subdivided into Blocks and Beats as in the Table 6. Forest Range is administered locally by one Range Forest Officer while each Block is in charge of Deputy Ranger and Beat under Forester or Senior Forest Guard. In addition, special duty Wildlife Guards are also employed for posting in sensitive blocks and beats to curb poaching. Forest fire-watchers are seasonally appointed on a temporary basis to attend to fire protection and monitoring exercise.

Table 6. The administrative divisions of the core area of Rupi Bhaba Wildlife Sanctuary

Forest Range	**Block**	**Beat**
1. Rupi	i. Rupi	a. Rupi b. Shamno c. Dabling
	ii. Chota Kamba	a. Chota Kamba b. Bara Kamba c. Shorang
2. Katgaon	i. Katgaon	a. Katgaon b. Homte c. Yangpa d. Shango e. Kangarang

Further details of Forest Range, Block, and Beat along with their boundaries are given in the Appendix 1.

2.13.2 Infrastructure

Housing for staff: At present, there are two residences for Range Officers one each at Rupi and Katgaon and two quarters for Deputy Rangers in the Sanctuary. There are ten Forest Guard huts inside the sanctuary. A majority of these residential buildings were old having been transferred from Nichar Forest Division when the wildlife division was created at Sarahan. See Appendix 2. for a list of staff-housings in Rupi Bhaba Sanctuary.

Office buildings: There are only two rest houses cum inspection huts in the Sanctuary. One Forest Rest House (FRH) at Rupi and another Staying Hut (Inspection Hut) at Salaring serve as the only base for visiting officials. There is no FRH at Katgaon. But the two field hostels belonging to the Himachal Pradesh State Electricity Board - one at Katgaon and another at Bhabanagar outside Sanctuary limits, are used by the Forest Department to put up visiting officials.

Road network: Road network is virtually non-existent inside the Sanctuary owing to the precipitous terrain. The only motorable road that exists between Katgaon and Kafnoo along Bhaba Valley trek was built by Sanjay Vidyut Pariyojana Project. However, there are a number of trekking trails and bridle-paths inside the sanctuary connecting different valleys. But most of them are badly maintained and are fit for use only in summer before monsoons. A list of major treks and bridle paths of the sanctuary is given in the Appendix 3 along with their current status of maintenance.

Observation posts: There are two watch-towers in the Sanctuary one at Rupi (at Shamno Dhar) and another at Bara Kamba. Sadly, both of them are in disuse. Though several below-ground bunkers were constructed on the recommendations of the first Management Plan (Pandey, 1991), a majority of them are in a dilapidated state and need renovation. For example, bunkers at Dumti, Yurang Dhar, Lankapuri valley, and Bhaba Valley (Mulling & Gyare) are strategically important and need immediate attention.

Equipment, vehicles, & other infrastructure: There are no stock records for the possession of various field-equipment like binoculars, range finders, GPS, compass, and survey instruments in the Range Offices. In the absence of such records, it is hard to assess the existing facilities. However, several newly recruited Forest Guards, who had just joined the service after their training in May 2008 were given a pair of binoculars each and some field-guides at the training centres. Similarly, it is difficult to take stock of the vehicular facilities exclusively available to the sanctuary management, as the Office of the Wildlife Division at Sarahan is also in charge of other PAs like Daranghati WLS and Lippa Asrang WLS. So it is not clear how many

vehicles are pressed into service in the field in Rupi Bhaba alone. But absence of roads inside the Sanctuary means that Rupi Bhaba probably needs vehicles only for easy access to outside the Sanctuary.

Fire infrastructure: Though seasonal fires are a major management issue in Rupi Bhaba Sanctuary, there are no fire-lines in the Sanctuary. There are only two watchtowers, as mentioned earlier, and they are also in disuse. There are also no trained fire-fighting squad in its field staff. During forest fires, Forest Rangers and Beat Guards would gather workforce locally to fight the fires.

Community infrastructure: There are 28 villages inside the buffer zone of the sanctuary and as such community facilities like child care centres, schools, women's welfare centres, primary health centres, civil dispensaries, community halls, regulated markets, post and telegraph offices, telecommunication booths, and panchayat buildings have come up in the past one decade. See Appendix 4 for village-wise list of community infrastructure and public amenities in the Rupi Bhaba Sanctuary.

2.13.3 Tourism

Though the neighbouring Great Himalayan National Park finds a prominent place in tourism map, Rupi Bhaba Wildlife Sanctuary remains virtually unknown in tourism circles. Remoteness, lack of road network, extremely strenuous trekking routes which are not maintained, absence of tourism infrastructure, and requirement of 'inner line permits' (which are no longer mandatory) are primary reasons why wildlife and adventure tourists are not attracted to Rupi Bhaba Sanctuary. However, Forest department has opened up Bhaba Valley in recent times for eco-tourism ventures; for example, the Himalayan Ecodrive a private ecotourism firm has begun its temporary camps in 2007. They run their trekking between May and July. Though the Resort Manager claims that they receive c. 1200-1500 trekkers every year, the figures are obviously much higher. During our field visit, we observed a total of c. 300 tourists in different camps of Himalayan Ecodrive. But the general awareness and eco-sensitivity of the Resort managers and the trekkers seem to be quite high, with little visible damage.

2.13.4 Active and Passive Interventions

As mentioned earlier, the current management of Rupi Bhaba Sanctuary seems to be more reactive than proactive with respect to tackling issues like forest fire, wildlife poaching, habitat degradation, forest encroachment, unregulated livestock

grazing, and illegal timber extraction. We observed a bare minimum intervention by Forest Department inside the Sanctuary even in places where such intervention was highly warranted. Lack of motivation, absence of training, extreme shortage of frontline staff, and deficient infrastructure are some of the key factors for this state of affairs.

However, some of the activities like maintaining nurseries for raising forest plants and regeneration efforts and soil compaction using boulder-nets to arrest erosion are quite visible. But there are hardly any attempts to evaluate the existing wildlife habitats and to improve them by identifying and removing the problems. For example, extensive areas of seemingly suitable habitats for Goral do exist in the Sanctuary closer to Sutlej Valley and lower Salaring valleys; but these steep grassy hills and ridges support very few individuals. No survey or study was undertaken in this regard to ascertain the exact status and suggest remedial measures. In another instance, mass-flowering and death of ringal bamboo that forms a key understorey of spruce-fir-oak mixed forests in Rupi and Shorang Valleys did not elicit any reaction from the management; these vegetations are the prime habitat for the endangered Western Tragopans. Absence of fire-lines in the Sanctuary indicates the level of preparedness on the part of the management to actively seek solutions to problems faced by the Sanctuary. For that matter, even the boundary pillars are not maintained in proper condition and in several places boundaries are not at all demarcated (e.g., Listegarang valley).

In the past, gun licenses were issued to locals for protection from wild animals esp. bears and leopards. After the notification of the Sanctuary, it became mandatory that those living in the close vicinity of 10 km or less from the nearest boundary of the PA should obtain necessary permission from the DFO. According to 1991 data, nearly 100 people have been granted permits to possess guns. See Appendix xx for a list of persons registered with the management of Rupi Bhaba Sanctuary for holding gun license.

2.14 Research and Monitoring

It is unfortunate that Rupi Bhaba Sanctuary has received little research inputs so far, and there also seems to be no sound, long-term population monitoring programme in place in the Sanctuary.

The only notable research activities (mostly in the form of short surveys) in the sanctuary include the following:

- Early floristic survey by Nair (1977): A pioneering work on documenting the flora of the entire Bushahr Himalayas.
- Faunal survey by Pandey (1991): Status survey and census of major mammals and pheasants in the sanctuary conducted as part of the first management plan.
- Survey of Himalayan Tahr by Kittur & Sathyakumar (2005): Survey of Lankapuri and Phupal Gad Valleys by the research team from Wildlife Institute of India – Dehradun as part of their survey of Himalayan Tahr in the entire Western Himalaya.
- Floristic survey by Jishtu et al. (2007): An authoritative checklist of the plants of Rupi Bhaba Wildlife Sanctuary compiled from a joint floristic survey by Wildlife Institute of India – Dehradun, Himalayan Forest Research Institute – Shimla, and Himachal Pradesh State Forest Department.
- Status survey of alpine meadows by Rawat (2007): Survey of the alpine meadows of Rupi Bhaba Wildlife Sanctuary with emphasis on their current status, floristic composition, and threats. – part of survey of alpine meadows of Western Himalaya by the Wildlife Institute of India, Dehradun.

The only other recent research activities include surveys, by our management plan team, of mammals, birds, herpetofauna, and vegetation communities during April-June, 2008. The results of these surveys are presented in the current management plan.

2.15 Developmental Activities

There were no developmental activities in the Sanctuary until late 1990s when the first mega hydro-electric project (Nathpa-Jhakri Hydel Project) was established and commissioned across Sutlej River near Nathpa, about 13 km away from the boundary of the Sanctuary. This project led to a large-scale infrastructure development in the region like upgrading of NH-22, telecommunication network, electricity, residential colonies, and commercial establishments. Though these developments took effect outside the Sanctuary limits, their spill-over impacts on livelihood options and local economy of communities living close to the forests were quite considerable. The environmental impacts of this hydel project on river water quality and riverine ecosystem in general were not adequately addressed to.

However, the recent trend of opening up the entire Sutlej River for setting up several mini and medium-scale hydel projects on a public-private partnership basis is

a matter of grave concern, as these projects cause enormous irreversible damage to the pristine river system through large-scale tunnelling and damming of waters. For example, a mini hydel project that is coming up at Salaring downstream is close to the Sanctuary limits. Similarly the supplementary feeder project to Nathpa-Jhakri Hydel Plant across Wanger Gad at Kafnoo near Katgaon (Bhaba Valley) has brought developmental activities right at the doorsteps of Bhaba Valley. It is still not clear what this development means to the local environment. But there is now a growing demand from the local people to convert the traditional trekking route to Bhaba Valley (Mulling Pastures) to a jeepable, all-weather pucca road at least till the sanctuary limits (a distance of 13 km).

In contrast to Bhaba Valley, there are no major developmental or infrastructural activities in Rupi and Shorang valleys. A jeepable hill road that would connect Bara Kamba and Chota Kamba to Bhabanagar across the Sutlej River is currently under construction, and this road is a long pending demand of the locals and would also pose no threats to the sanctuary.

2.16 Conflicts and Constraints

Like any other mountain PA of the western Himalaya, Rupi Bhaba Sanctuary is also riddled with several management issues and rows. Some of the major conflicts include the following:

Poaching of wildlife: Though poaching seems to be on the wane in recent times (mainly owing to increased vigilance by the PA authorities and availability of employment opportunities in the hydel projects), it was so rampant in the past that it has already taken a heavy toll on local populations of some of the threatened species like Himalayan Tahr, Goral, Musk Deer, and pheasants including Himalayan Monal and Western Tragopan. The fact that poaching still continues to plague certain pockets of the Sanctuary means that it rightfully tops the agenda of Sanctuary management.

Unregulated grazing: Every summer, thousands of livestock are taken to high-altitude alpine pastures in nomadic shepherd camps (Table 7). Though regulation of the number of camps along with seasonal staggering mechanism is put in place by Forest Department, these guidelines are not strictly adhered to and number of illegal shepherd camps far exceeds that of licensed camps. This has put enormous pressure on the fragile alpine ecosystem, with their carrying capacity under severe stress.

Timber distribution rights: A recent restriction on timber distribution and use imposed by the Forest Department has deprived the local people of their traditional rights, bestowed by the Bushahr State Settlement -1921, for access to timber for

construction of buildings. This move has come in for severe criticism as houses in Kinnaur are traditionally built with wood for heat insulation during cold winters. This has also given rise to a surge in illegal felling of trees for timber in forests close to villages.

Human-wildlife conflicts: Though cases of human-wildlife conflicts are relatively low in Rupi Bhaba Sanctuary in comparison to some of the other mountain PAs in western Himalaya, instances of people-wildlife confrontations are increasingly being reported in some parts of the sanctuary. In particular, Rupi and Salaring Valleys are more vulnerable to such conflicts. Damage to potato crops by porcupines, cattle lifting and depredation by Common Leopards at lower altitude and Snow Leopards in alpine pastures, and attacks of human beings by Black Bear are some of the major sources of human-wildlife confrontations.

Forest fire: Forest fires are historically a scourge for the management of forests in western Himalaya, and instances of wildfire are also reported to be high in parts of Rupi Bhaba Sanctuary (e.g., Shorang and Salaring Valleys). Dried up needles of conifers on the forest floor, being highly inflammable, often exacerbate the fire. The management of the sanctuary is unfortunately ill-equipped and understaffed for fire control and monitoring.

Though the PA management, since the inception of the Sanctuary, had attempted to face these challenges, their efforts and measures did not yield desired results owing to several constraints and limitations. The extreme remoteness and inaccessibility of major portions of the Sanctuary are a prime constraint in addressing the issues in time. Heavy snowfall in winter and landslides during rains mean that most of the access paths to interior valleys are sealed. The management is also crippled by a severely understaffed workforce who also has to manage the Sanctuary with bare minimum infrastructural facilities and resources. In some parts, infrastructure is absolutely absent. For example, it is not uncommon to find that most of the frontline and lower level staff are engaged in multitasking like anti-poaching camps, fire-fighting missions, civil works, and wildlife population monitoring. Rupi Bhaba Sanctuary is managed by the DFO, Sarahan Wildlife Division who is also in charge of other PAs in the region (Daranghati and Lippa Asrang WLS) besides the captive breeding facility of pheasants at Sarahan Pheasantry. Thus, the office of the DFO (Wildlife) is heavily burdened with the administrative workload that affects management effectiveness. Absence of infrastructure also means that the Sanctuary receives much less attention from research organizations and tourism industry. Absence of long-term research led to huge gaps in our understanding of the local ecosystem and in knowledge of the status and distribution of threatened wildlife.

Thus, management of the Sanctuary is largely bereft of research inputs. The Sanctuary is also not able to raise its own funds as options of adventure and eco-tourism, major sources of income (and foreign exchange) for a mountain PA, are undersold in Rupi Bhaba Sanctuary.

Table 7. Livestock population in adjoining villages within Rupi and Katgaon Ranges of Rupi Bhaba Wildlife Sanctuary

S.No.	Species	Rupi Range	Katgaon Range	Total
1	Cow	471	1840	2311
2	Ox	224	320	544
3	Sheep	3239	18000	21239
4	Goat	1865	6000	7865
5	Horse	-	80	80
6	Donkey	-	60	60
7	Mule	-	30	30
8	Others	108	-	108
	Total	**5907**	**26330**	**32237**

Chapter 3. Diversity and Distribution of Biodiversity Components

3.1 Forest Types

As stated elsewhere, the following 17 types of forest associations belonging to six vegetation classes (as per the classification by Champion and Seth, 1968) are to be found in Rupi Bhaba Wildlife Sanctuary.

1. **SUBTROPICAL PINE FORESTS**

Type 9/C_1. Himalayan subtropical pine forest

1b. Upper or Himalayan chir pine forest

- Scattered trees of Chir pine (*Pinus roxburghii*), with undergrowth of *Indigofera* spp., *Desmodium* spp., and *Rubus* spp. Seen mostly as immature and irregular crop along Sutlej River at Neoul, Kachrang, Nathpa, and up to Wangtu.

2. **HIMALAYAN MOIST TEMPERATE FORESTS**

Type 12/C_1. Lower Western Himalayan temperate forest

1a. Ban oak forest

- Dominated by *Quercus incana* (*ban* oak), mostly in association with a few trees of blue pine, deodar, and spruce. Mainly below c.2400. Found in small patches near villages of Rupi and Salaring valleys. The village Rokcharang has a good patch of almost pure ban oak and the local deity (devta) is, in fact, named after this stand.

1b. Moru oak forest

- Dominated by *Quercus dilatata* (*moru* oak). 2400-2600m. Small degraded isolated patches in Rupi and Shorang valleys.

1c. Moist deodar forest

- Dense, moist forest of deodar (*Cedrus deodara*) with a few *Pinus wallichiana*. 2300-2600m. Very few patches in Rupi and Shorang valleys.

1d. Western mixed coniferous forest

- The most predominant vegetation type in Rupi, Shorang, Salaring, and Lower Bhaba valleys, between 2400 and 3200m. Association includes *Picea smithiana* (Himalayan spruce), *Abies pindrow* (silver fir), *Pinus wallichiana* (blue

pine), and a few deodars either as pure stands (rare) or commonly in different combinations (depending on edaphic factors and aspects). Luxuriant undergrowth and herbaceous layer. Grazing is heavy and very prone to forest fires during summer.

1e. Moist temperate deciduous forest

- Includes temperate broadleaved trees like *Acer* spp. (maples), *Aesculus indica* (horse-chestnut), *Juglans regia* (walnut), *Ulmus wallichiana* (Himalayan elm), and *Prunus cornuta* (bird cherry). 2200-2800m. Commonly found in moist valleys and along stream-banks. Mainly in Rupi valley and Lankapuri in Salaring valley.

1f. Low level blue pine forest

- The blue pine or kail (*Pinus wallichiana*) occurs in association with deodar. Found at lower altitudes (up to 2300 m) throughout the sanctuary.

Type 12/C_2.Upper Western Himalayan temperate forest

2a. Kharsu oak forest

- Dominated by *Quercus semecarpifolia* (*kharsu* oak). On southern aspects, blue pine runs right up to kharsu oak forests. 2600-3300m. A dominant vegetation type in Shorang valley and Lankapuri and Phuphal Ghad valleys (of Salaring). Canopy is too dense even for its own seedlings to emerge. Patches of regeneration saplings frequently seen on ridges where Monals had dug up soils for foraging or resting.

2b. West Himalayan upper oak/fir forest

- An uncommon association of *Abies pindrow* (silver fir) and *Quercus semecarpifolia* (*kharsu* oak). 2500-3100m. Some stretches are to be found in Lankapuri and Phuphal Ghad valleys.

Seral type $_1S_1$. Alder forest

- Nearly monospecific linear stretches of *Alnus nitida* (alder, locally known as *kunees*) along the riverbeds close to banks mainly between 2100 and 2500m. Quite a few patches to be found along downstream of Lankapuri, Phuphal Gad, and Salaring rivers.

3. **HIMALAYAN DRY TEMPERATE FORESTS**

Type 13/C_1. Dry broadleaved and coniferous forest

- Mainly association of *Pinus gerardiana* (*Chilgoza* pine) and *Quercus ilex* with some deodar trees. 2100-2600m. Found along high elevations in main Sutlej valley; *Chilgoza* pine cultivated in a few localities.

Type 13/C_2. Dry temperate coniferous forest

2b. Dry deodar forest

- Nearly monospecific stand of open deodar trees with some scattered blue pine. 2100-2500m. A few patches occur between Chota Kamba and Yurang dhar (Shorang valley).

4. **SUB-ALPINE FORESTS**

Type 14/C_1. West Himalayan sub-alpine birch/fir forest

1a. West Himalayan sub-alpine high level fir forest

- Predominantly *Abies spectabilis*. Chiefly above 3000m, but below birch scrub. Some patches can be seen in Upper Listegarang valley and Bhaba valley.

1b. West Himalayan sub-alpine birch/fir forest

- A high-altitude association of *Abies spectabilis* and *Betula utilis* (birch) with some *Rhododendron campanulatum* shrubs. 3000-3300m. Some large patches are found around Mulling pastures in Upper Bhaba valley.

5. **MOIST ALPINE SCRUB**

Type 15/C_1. Birch/Rhododendron scrub forest

- Stunted growth of *Betula utilis* (birch) with *Rhododendron campanulatum* shrubs. 3200-3500m. Upper Bhaba valley.

Type 15/C_3. Alpine pastures

- High-altitude alpine pastures, above treeline (c. 3500m and above). The slopes are usually gentle and bear a thick mat of alpine grasses sometimes with a heavy presence of rocky outcrops. Snowbound between November and April. Some of the common herbs include *Primula* spp., *Anemone* spp., *Gentiana* spp., *Jurinea* spp., and *Aconitum heterophyllum*. Common grasses are *Andropogon munroi*, *Brachypodium sylvaticum*, *Blymus compressus*, *Poa* spp., *Dactylis glomerata*, and *Millium effusum*. Some of the prominent alpine pastures in RBWLS include Yurang dhar in Shorang

valley, Upper Phuphal valley, Kara, Mulling, and Deiya pastures in Upper Bhaba valley, and Pandoshwar pasture in Listegarang valley.

6. **DRY ALPINE SCRUB**

Type 16/C1. Dry alpine scrub

- Dwarf alpine shrubs mainly composed of *Juniperus macronoda*, *Artemisia maritima*, *Caragana* spp., *Lonicera* spp., and *Ephedra* spp. Found in high-altitude cold and arid tracts in the north-eastern parts of Bhaba valley contiguous with Pin Valley National Park.

3.1.1 Management Prescriptions

Mapping of vegetation types along with other physiographic features like contours, slope, and aspects should be undertaken with the aid of modern GIS tools. Existing spatial data like SoI toposheets (1:50,000 scale) and satellite imageries can be used in conjunction with extensive ground-truthing on the field. The task should be assigned to professional organizations with vast experience in developing such vegetation maps in natural areas (Appendix 13). Field staff should be trained to use modern tools such as GPS and GIS. A dedicated team needs to be identified and trained at Indian Institute of Remote Sensing or Wildlife Institute of India to document vegetation change. Photographic monitoring of sites/vegetation types could also be done.

3.2 Vegetation Composition

See Appendix 7 for a description of vegetation composition of upper storey and undergrowth in each forest in Rupi Bhaba Sanctuary (after Pandey, 1991).

3.2.1 Management Prescriptions

- Beat and compartment-wise mapping of vegetation composition should be taken up after intensive sampling in the field. A schematic diagram showing the protocol of this vegetation sampling is provided in the Appendix 6.
- There should also be a mechanism for long-term monitoring of vegetation changes in response to various levels of natural causes and disturbance from human activities. This is essential to draw up contingency plans in order to protect the integrity of wildlife habitats. But steep and precipitous terrain of the sanctuary means that it may not be feasible to lay large vegetation plots in all the habitat types, and monitoring sites have to be chosen on the basis of terrain and intensity

of threat perceptions. In particular, alpine meadows and pastures are the most threatened wildlife habitat in the Western Himalaya, as they suffer from livestock overgrazing and high-intensity tourism activities. The smoother terrain of alpine meadows also makes them amenable for establishment of vegetation monitoring plots. It is estimated that over 30% of the Rupi Bhaba Sanctuary is covered by alpine pastures. Reference plots in the form of 100 X 100 m (1 ha) permanent enclosures should be established in a few major alpine pastures of the sanctuary. The enclosure should be made up of metal-wire fence and should be strongly anchored to the earth by means of sufficient number of concrete pillars. The height of the fence should at least be 1.5 m height to deter domestic livestock. Standard vegetation plots of different sizes (from 1 sq.m to 5 sq.m) can be laid within the enclosure to measure variables of concern like density of alpine herbs, medicinal plants, and grasses.

- Regular, periodic checking for the presence of invasive weeds should be undertaken by the beat level officers and Forest Guards. Though there are currently no major threats from weeds in Rupi Bhaba, we observed the presence of invasive species like *Lantana camara* along Sutlej Valley, *Eupatorium odoratum* in moist interior valleys, and *Anemone* spp. and *Rumex* spp. in alpine pastures. The fact that these weeds can proliferate in a short span of time means that there has to be a constant vigil and anti-weeding exercise to eradicate them in the initial stages. Forest fire, cattle grazing, and grass cutting often lead to colonization of these weed species and weeding operations need to be intensified especially in those areas which are prone to such disturbances.
- Uprooting of *Lantana* will help control this species invasion. By close monitoring of the other weed species, complete removal during initial stage would help check the species invasion.

Hackelia uncinata *Trifolium repens* *Potentila nepalense* *Arisaema flavum*

Marsdenia royleii *Cynanchium auriculatum* *Silene inflate* *Pedicularis sp.*

Abies spectabili *Picea smithiana* *Pinus wallichiana* *Corylus jacquemontii*

Epipactis sp. *Arisaema propinqum* *Monotrapa sp.* *Neotia listerroides*

Iris kemauensis *Mecanopsis aculeate* *Pedicularis sp* *Podophyllum hexandrum* *Bistorta affine*

3.3 Vegetation Communities of Bhaba Valley

A weeklong vegetation survey was conducted as part of this management plan in Bhaba Valley in two stages: from Katgaon (Kafnua) to Mulling (Bhaba trek) and from Mulling to alpine meadows that lie ahead (Dea and Kara pastures). Since the primary objective of the survey was to document the floristic diversity of the area and record the broad vegetation types, no systematic sampling method was employed.

I Kafnu to Mulling

The 15 km long trek towards the alpine meadows of Mulling starts from the village Kafnu. The initial parts of the valley have been heavily reclaimed and are mostly used for growing orchards. The vegetation otherwise along the path is mostly herbaceous consisting of *Potentila nepalense*, *Arisaema spp* (cobra lily), *Impatiens*, *Hackelia*, *Parochaetus communis* and *Trifolium repens* (white clover). These remained consistently common throughout the way since such species grow abundantly in heavily grazes areas and favor nitrogen rich soils. Others which were recorded only at this elevation were *Marsdenia royleii, Cynanchium auriculatum, Nepeta erecta, Silene inflate, Pedicularis sp Hippophe salicifolia* and *Salix sp* together formed the riverine vegetation along with occasional *Populus* (poplar). The river banks are an important habitat for the medicinally important *Hippophe* tree primarily because this species almost exclusively grows only along the slopes immediately adjacent to river bank. We observed such habitats being converted into apple orchards at few places near the village.

Low-elevation temperate broadleaved mixed forest: The broad leaved vegetation communities primarily consisted of *Acer spp* (Maple), *Syringa emodi*, Juglans regia (walnut), Corylus jacquemontii (hazelnut).

Mixed coniferous forest: Coniferous forests were primarily composed of *Abies spectabilis* and other species recorded in varying abundance were *Pinus wallichiana* and *Picea smithiana*. However these three species were found growing sympatric at only one location in the entire valley.

Pure Abies Forest: *Abies spectabilis* was the most abundant among the coniferous species and formed mono-dominant old growth forests (with very few scattered maple and birch). The most commonly observed understory species consisted of mostly Pteridophytes and rhizomatic, bulbous herbaceous geophytes such as *Arisaema propinqum* (Cobra lily), *Epippactis* sp. (Ground orchids), *Trillidium*, *Valeriana*, *Galium* and *Impatiens*. A few saprophytic species were also recorded in this forest such as *Neotia listerroides* (ground orchid) and *Monotrapa* sp. (saprophytic rhizomatous herb).

Sizable populations of medicinally important *Taxus baccata* were recorded only at two locations. Both these populations were found on steep shady valley slopes under the canopy of *Abies*. A majority of these plants however appeared very stunted and deformed. The main reason for the deformed growth of these trees was that most of these trees were found to be heavily debarked. In addition we observed a few big saw felled trees of *Abies spectabilis*. However the trees could have fallen naturally of old age and then sawed later. But still these signs indicate that there is no check or proper patrolling in the area and even big trees along with other forest produce is still being collected from the wildlife sanctuary.

The vegetation types mentioned above are not continuous with each other but very patchy and often alternate with large openings created by herders before the notification of the sanctuary. These were utilized for camping and also for some minor crop cultivation.

These openings are now occupied by weeds herbaceous plants and are occasionally used by tourists for overnight camping. We recorded three such openings presumably made by clearing of forest because such areas were surrounded by old forest of *Abies* and other conifers.

Birch forest: *Betula utilis* (Birch) started appearing from an altitude of about 2800m. However occurrence of paper-birch did not mark the tree line. Birch trees were often seen to be associated with maple and *Abies* but not very far from the stream sides. Only at an elevation of about 3200m and above it started forming pure stands extending from stream banks to high up till the steep mountain slopes.

II Mulling & Upper Bhaba Valley:

The alpine meadow of Mulling is located at an altitude of 3286m. The meadow (now turned into pasture land) is being extensively used for grazing by livestock. The meadows particularly on the right bank of the river are being grazed to such an extent that the entire meadow (until where the steep climb starts) is covered by *Rumex* and *Anemone*. These two species which are avoided by livestock flourish in heavily grazed, which get constantly supplied with livestock dung. (During a single count from the campsite of Mulling we recorded 48 cows and more than 100 sheep). Tourism also seems to be affecting the meadow severely since tourists often take along a large number of mules which add further to the grazing pressure. As compared to the opposite bank where *Abies* and *Betula* trees extend through the meadows, right up till the stream in some places, trees on the right bank meadow have been pushed to the steep mountain slopes (could be because of the aspect or

due to disturbance and use by herders over many years). One can only observe a different set of species on substratum and debris accumulated on big boulders or among *Berberis-Morina* thickets which are inaccessible to the livestock and therefore offer kind of a safe site for these alpine herbs. We found a strikingly higher abundance of medicinally important *Dactylorhiza hatageri* growing among the armed bushes of *Berberis* and *Morina*.

Alpine Flora of Mulling: (*Rumex-Anemone* Vegetation Type)

As mentioned above most of the meadows in Mulling area heavily degraded and dominated by only a few (unpalatable) species such as *Anemone obtusiloba, Rumex sp*. and *Geranium, Trifolium repens* (clover) *Hackelia and Lindelofia*. Other species which were recorded along with these were *Ranunculus, Hedysarium sp., Silene nigrescens, Valeriana sp., Anaphalis, Erigeron Potentila spp, Fragaria sp,* and *Thymus linearis*. Species that were observed growing only along small water courses were *Caltha palustris*, *Pedicularis pectinata*, *Myricaria rosea*, *Hypericum sp*., and a few species of sedges. In addition to this the meadows supports a good population of *Podophyllum hexandrun*, an endangered medicinal plant distributed in Garhwal Himalayas having anticancer and healing properties. This plant which is normally seen in shady forest under-storey was found to be growing commonly on open meadows of Mulling. These meadows also have patches of sparse stunted woody vegetation consisting of *Viburnum sp.* and *Salix sp*.

The meadows of Mulling had a few patches which were drier than the surroundings because of different (sandy) soil type. These slopes were mostly rocky and with many boulders and was characterized by very sparse vegetation. However the vegetation composition in these areas was different consisting of mostly rock loving species like *Saxifraga brunonis, Arenaria sp., Lonicera sp., Thymus linearis, Iris kemaunsis, Bistorta affine, Juncus sp, Androsace sarmentosa* and others such as *Arisaema jacquemontii, Mecanopsis aculeate, Pedicularis bicornuta*.

From Mulling further exploration was carried out in areas higher up in the valley towards a place called Bhaba-Top. We walked about 8-10km further up in the valley in search of undisturbed meadows where herders don't go or grazing doesn't take place. However we did not find any such areas where grazing does not take place since herders and tourist often take this route to go all the way till Pin Valley. However we did observe a fair amount of turnover in species communities with change in altitude.

High-elevation temperate broadleaved mixed forest: Even though the meadows of Mulling start at an altitude of 3200m, the tree line doesn't end there. In fact we came across a patch of broadleaved forest and *Abies* forest some four km after Mulling. The broad leaved forest comprises of species such as *Prunus sp, Acer sp, Sorbus sp.* and *Betula utilis*. We did not record any woody vegetation after this elevation. The under-storey consisted of dense herbaceous growth of *Hackelia uncinata, Impatiens sp, Persicaria polystachya* and *Polygonum spp*.

The vegetation along the river consists of dense (*krumholtz* like) woody growth of *Rhododendron companulatum, Salix sp*. and *Betula utilis*.

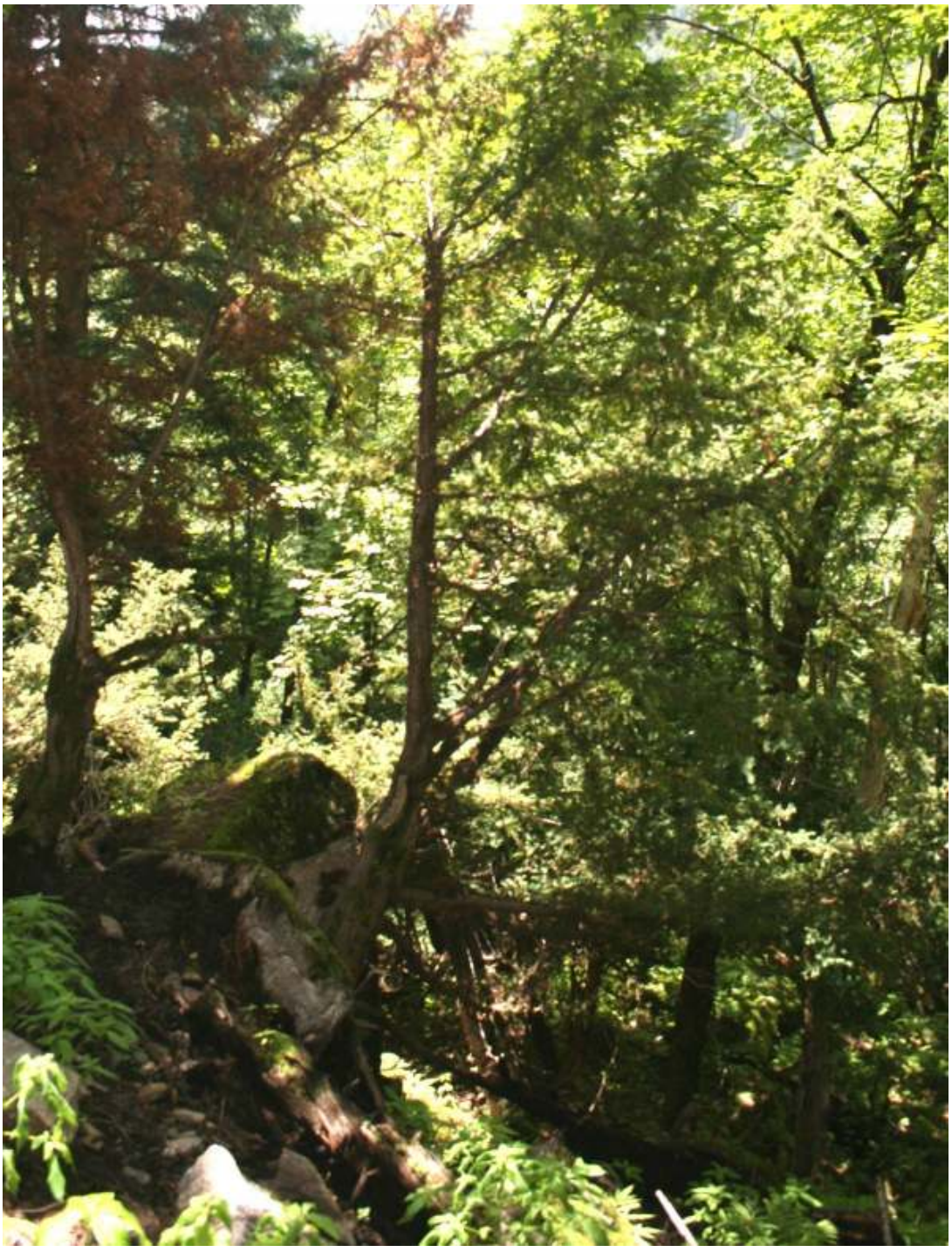
As one goes further up to Bhaba Top, the valley becomes very narrow and the gradient very steep. Here the valley slopes are mostly dry with very unstable substratum and evidently prone to frequent landslides. The species that were seen growing on such slopes were mostly generalists like the Himalayan thistle (*Cardus edelbergii*) and *Verbascum thapsus* which are always first to colonize the areas exposed after a landslide.

Riverine Meadows: After a steep stretch of two km, the valley again becomes very broad with a very flat and basin. As a result the river also flows very gently and is perhaps the broadest at this stretch. Due to this there are several islands formed due to deposition of silt and other residual matter carried down by the river. We observed a very high species diversity of alpine plants along the river and on the islands at this place. Also we did not record any direct or indirect signs of livestock use or movement on these islands in particular although they were present in good numbers on the adjacent hills and slopes. The species which formed this riverine community were *Pedicularis* (4 species), *Parnesia, Taraxicum*, *Myricaria, Salix nepalense, Anaphalis, Impatiens, Primula involucrate, Aster, Euphresia, Thymus linearis, Podophyllum hexandrum, Gymnadenia orchioides, Dactylorhiza hatageri, Sibbaldia, Gentianella, Potentilla* (2 species), *Juncus, Carex, Androsace, Eritricum, Allitris pauciflora, Epilobium and Phlomis bracteata*.

Broad leaved forest type

Abies dominated forest

Debarked and consequently deformed trees of *Taxus baccata*



Pure-stand of *Betula utilis* forest

Heavily grazed meadows of Mulling showing high dominance of *Anemone* and *Rumex*

Rhododendron-Salix vegetation (riverine)

Riverine meadows near Bhaba-Top

Sedge (Boggy) meadows dominated by majority of graminoides and very few herbs

Bridge connecting the two sides of the mulling valley, a potential site for development of a nature trail.

3.4 Mammals

Rupi-Bhaba Sanctuary is home to about 65 species of mammals including some Himalayan charismatic species like Snow Leopard, Himalayan Tahr, Brown Bear, Himalayan Weasel, and pikas However, mammal populations are generally low in density, barring a few species like Serow and Common Leopard. Heavy disturbance owing to movement of nomadic shepherds and mushroom collectors, habitat degradation due to overgrazing by livestock, and poaching (which was rampant till recently) are the primary causes.

Bats:

No systematic study on bats of Rupi-Bhaba WLS exists and therefore the place lacks even a basic checklist. We have drawn up a provisional list on the basis of the known distribution ranges of bats across Himalayas and 12 species of bats are expected to occur in RBWLS. The fact that there are quite a few small to large rocky caves particularly in Upper Lankapuri and Phuphal Ghad valleys underscores the importance of these 'unique habitats' for bat populations. Rock-face shelters forming shallow caves (locally known as 'dwars') are often used for camping by shepherds and guchchi mushroom collectors, and these dwars sometimes hold small bat populations. Some of these dwars in the interior valleys may be surveyed intensively for a baseline assessment of bat populations.

Primates:

There are only two species of primates in Rupi-Bhaba WLS. Though Common Langurs (*Semnopithecus entellus*) are seen even at higher altitudes up to c. 3200m (e.g., Listegarang Valley), they are not widespread. Their patchy distribution is worth investigating. Langurs are an important prey for Common Leopards in Rupi-Bhaba as their wild preys are dwindling in numbers. We found in our survey a large localized population of Common Langurs foraging among the temperate forests high up the ridges of Upper Lankapuri Valley (2550-3200m); these langurs looked clearly different from their cousins in plains in that they had snow-white hairs on body (*contra* dark-grey) and tail. Moreover, their alarm calls were very different from the alarm calls of the peninsular populations; the alarm call was more like a clear single-noted deep exhalation that had a curious ringing tone. Though Common Langurs are known to exhibit great variations in their morphology and behavior, genetic studies need be conducted to examine the taxonomic significance of the Lankapuri population. The other primate Rhesus Macaque (*Macaca mulatta*) occurs in very small patches (e.g., one troupe near Chota Kamba and another in Lower Phuphal Ghad forests).

Carnivores:

Common Leopard (*Panthera pardus*) is the predominant predator in Rupi-Bhaba WLS, being present in all the valleys of the Sanctuary up to 3200 m in Listegarang and Bhaba valleys. Gauged from the relative frequency of signs and other indirect evidences, their numbers seem to be quite high in the Sanctuary. But the predator population is certainly not matched by their wild prey populations (that comprise mainly goral and langurs). This has led to increasing number of human-wildlife conflicts as leopards often take cattle from mountain villages. This issue is particularly rampant in Rupi and Salaring valleys.

Snow Leopard (*Uncia uncia*), the flagship species of high-altitude mountain ecosystem in the Himalayas, suffers from the same malaise that Common Leopard does: scarcity of wild prey populations. Though we did encounter quite a few signs of Snow Leopard in Upper Bhaba Valley (including a couple of cattle kills possibly by this species), there were no significant populations of prey species like Bharal or Himalayan Tahr owing to heavy presence of nomadic shepherd camps and possibly poaching. This has given rise to increased instances of livestock depredation by Snow Leopards in alpine pastures during summer. In winter, Snow Leopards are known to descend much lower in search of livestock. In these times, they are sometimes trapped and killed by locals; one mother and cub were apparently killed by local villagers near Katgaon two years ago.

Among the small cats, Leopard Cat (*Prionailurus bengalensis*) seems to be quite abundant particularly in inner valleys of Shorang and Lankapuri. Local people in Chota Kamba and Bara Kamba villages frequently complain of small wild cats predating on their poultry; investigation of pugmarks led us to believe that they may be Leopard Cats. The distribution of Jungle Cat (*Felis chaus*) needs to be corroborated as the only evidence that we came across was in Rupi Valley.

Yellow-throated Marten (*Martes flavigula*) is another key predator in Rupi-Bhaba WLS and occurs in good numbers. We had several sight records of this species in Rupi, Shorang, Lankapuri, and Bhaba valleys. Himalayan Weasel (*Mustela sibirica*) is quite common particularly in high-altitude thatches as it prefers to inhabit stonewalls raised by the shepherds to protect their cattle camps. One Himalayan Weasel was seen foraging among rock-piles in Yurang Dhar (3800 m) near Shorang valley. Shepherds often claim that the young kids of sheep and goats are very vulnerable to predation by Stone Martens (*Martes foina*) in the upper alpine pastures.

Among the canids, Red Fox (*Vulpes vulpes*) is the commonest species in the higher altitudes (>3000m). Their scats and pugmarks were frequently seen in Upper

Shorang Valley and Upper Bhaba Valley. Jackals (*Canis aureus*) were seen only around mountain villages of Sutlej Valley and near Katgaon; they were not encountered in the interior valleys.

Both the species of Asiatic Black Bear (*Ursus thibetanus*) and Himalayan Brown Bears (*Ursus arctos*) occur in Rupi-Bhaba with the former between 2100 and 3000 m and the latter at above 3300m altitudes. The Black bear is feared by the locals as number of attacks by these bears on humans is quite high in this part of the Himalayas; in particular, the Rupi and Salaring Valleys are prone to human-bear conflicts. Local villagers in these valleys have been demanding protection measures from Forest Department and adequate compensation for victims. Though instances of attacks from Brown bear are few and far between, they do take goats and sheep in alpine pasturelands during summer.

Ungulates:

A worrying feature of mammal populations in Rupi-Bhaba WLS pertains to the apparent scarcity of wild ungulates. Barring Serow (*Naemorhaedus sumatransis)*, all the wild ungulates are found in extremely small numbers. Heavy poaching in the past seems to be the overriding cause though habitat degradation and disturbance by shepherd camps and livestock grazing also contribute to the population decline. Serow, probably owing to its close resemblance to cow, is generally spared by poachers. In our knowledge, Rupi-Bhaba is probably the only PA in the entire Western Himalayas that has a significant population of Serows (locally known as emmu). In view of the fact that Serow remains little studied in India, we strongly recommend Rupi-Bhaba as a potential site for intensive ecological research on biology and management of Serow (Appendix 13).

Locally known as mushknapha, the Musk Deer (*Moschus chrysogaster*) has been hunted extensively in the past for the commercially valuable musk-pod, an abdominal gland in the males. A solitary and secretive animal, it is found between 290 and 4000 m elevation range in Rupi Bhaba Sanctuary. Lankapuri Valley, Phupal Gad Valley, and Upper Bhaba Valley hold significant populations of Musk Deer in the sanctuary.

Though Gorals (*Naemorhaedus goral)* are still found in hills and cliffs even outside the Sanctuary limits (e.g., Salaring FRH), their population is alarmingly low. Considering the fact that suitable habitats are still to be found throughout the inner valleys, it is a matter of grave concern that the gorals are slowly disappearing. Unfortunately, this grim scenario also holds true for the mountain-ungulate populations in the high-altitude plateaus and ridges of Rupi-Bhaba WLS.

Though Himalayan Tahr (*Hemitragus jemlahicus*) is still found in small numbers in Shorang, Lankapuri, and Listegarang Valleys, the current population is far from ideal. The status of Asiatic Ibex (*Capra ibex*), said to be residing in deep interior cliffs and gorges of Upper Bhaba Valley is not fully known, as a large part of its range is virtually inaccessible. The populations of Bharal (*Pseudois nayaur*), which the local shepherds claim that they were quite common till a decade ago in Upper Bhaba Valley, have become insignificant in recent times. It has been sighted reliably in the past from alpine meadows like Pandoswar, Palasnud, and wastich in Bhaba Valley and Kumrang in Shorang Valley. It is hoped that small populations may still hold out in some of the interior valleys along Wangsham Ghad (e.g., near Deiya Glacier).

Flying Squirrels:

Unlike other mammalian taxa, flying squirrels are fortunately quite common in Rupi-Bhaba WLS. Both the Red Giant Flying Squirrel (*Petaurista petaurista*) and Small Kashmir Flying Squirrel (*Hylopetes fimbriatus*) at a higher altitude seem to be thriving well especially in oak-dominant temperate forests of Rupi and Shorang valleys. A comprehensive survey is required to study the exact status, distribution, and ecology of these giant squirrels, and Rupi-Bhaba WLS is potential site for such studies. Indian Crested Porcupine (*Hystrix indica*) occurs close to villages and cultivation and they often cause enormous damage to potato crops.

Pikas:

Often considered as 'keystone' species of high-altitude alpine pastures, Pikas play an important role as prey for several small carnivores. Both Royle's Pika (*Ochotona roylei*) and possibly Large-eared Pika (*Ochotona macrotis*) are to be found in good numbers in rock-strewn high-altitude plateaus of Rupi-Bhaba WLS. In particular, Yurang dhar (3800m), Upper Bhaba valley (3400m), and Pandoshwar pasturelands in Listegrang Valley (3300m) hold good populations. It is however not clear how livestock grazing affects these pika populations, as these sites suffer from onslaught of heavy cattle grazing during summer.

3.4.1 Management Prescriptions

- Regular wildlife surveys should be conducted in select trails and localities to monitor the status and distribution of mammal populations. In this regard, premier institutes like Wildlife Institute of India, Dehradun may be sourced out to provide adequate training to the forest staff in wildlife census and techniques.

- The faunal composition of lesser mammals like bats, rodents, small cats, and mustelids is insufficiently known from the Sanctuary. Relevant subject experts from other organizations like Zoological Survey of India, Wildlife Institute of India, universities, and research NGOs can be approached for authoritative species inventories for these lesser known taxa.
- Wild ungulate populations could be augmented by active management of grasslands in their potential habitats, and protection measures needs to be strengthened to prevent any poaching incidents. These would help improve wild prey status, which will have ramification in reducing human-wildlife conflict.

National institutes and universities can be asked to take up the following research proposals for detailed study on small mammals in the sanctuary (Appendix 13):

- Inventory of bats and their traditional roosting caves, and assessment of their numbers inside Rupi-Bhaba WLS
- Genetic studies to ascertain taxonomic status of Common Langur populations that are found in high cliffs and ridges in Upper Lankapuri Valley (2500-3200m)
- Ecology of flying squirrels and their role in oak regeneration in temperate forests
- Impacts of livestock grazing on pika populations in alpine areas
- Food habits of high-altitude mustelids with particular reference to their predation of small livestock

3.5 Avifauna

Though Rupi-Bhaba WLS has a wide elevational range from 2100 to 6000m and represented by both Great Himalayan and Trans-Himalayan ranges, its birdlife (with a little over 200 species) is not as exceptionally rich as either GHNP in the west or the Garhwal Himalayas in the east [See Appendix 8 for a provisional list of the birds of Rupi-Bhaba WLS]. The major factor is the predominance of dry temperate coniferous forests which support very few bird species and patchy distribution of temperate broadleaved vegetation including oak-rhododendron mixed forest which is known to harbour high species diversity of birds in the Western Himalayas. This also explains why some of the common birds of Western Himalayas like hill-partridges, hawk-cuckoos, jays, laughingthrushes, sibias, and sunbirds are either rare or locally absent in Rupi-Bhaba. However, the birdlife of the Sanctuary is rich in some avian

taxa like pheasants, raptors, swifts, warblers, thrushes, flycatchers, chats, robins, and finches. Presence of habitat-specialists like Eurasian Woodcock, Wood Snipe, and Solitary Snipe which breed in high-altitude marshes and alpine meadows further underscores the importance of Rupi-Bhaba WLS for conservation of Himalayan avifauna. Further, one of the Indian Subcontinent's rarest birds, the Large-billed Reed Warbler (*Acrocephalus orinus*) was first described from one specimen collected from Sutlej Valley near Rampur in 1867 and it was never found again till its recent rediscovery in Thailand in 2006 after a gap of 139 years (Round et al., 2007).

Galliformes:

Rupi-Bhaba WLS harbours very significant populations of at least nine species of Galliformes (pheasants & partridges) including Western Tragopan, a flagship species for biodiversity conservation in the Western Himalayas. Western Tragopans are particularly common along Shorang valleys and inner valleys of Lankapuri. The fairly high frequency of their encounters makes Rupi-Bhaba a potential destination for ecotourists and birdwatchers and a good alternative to GHNP in this regard.

Rupi-Bhaba WLS also has a healthy population of Koklass pheasant and Himalayan Monal. The Kalij Pheasant, however, is quite scarce in Rupi-Bhaba, owing to higher altitudinal range of the Sanctuary and lower extent of broadleaved temperate forests.

In the past, Cheer Pheasants were quite common in the dry scrub-covered ridges along downstream valleys of Rupi, Shorang, and Salaring, and they particularly favour early successional habitats. But their population has suffered a heavy decline in recent times as these scrubs have been largely converted to crop-fields.

Chukar partridges are distributed patchily in Rupi-Bhaba WLS, across a very wide elevational range from 2100 m (Salaring) to 3800 m (Yurang dhar). They are also frequent along lower Listegarang Valley (2300 m).

Among the high-altitude Galliformes, Himalayan Snowcocks were quite common in both Yurang dhar (3800m) and Upper Bhaba Valley (>3300m). Though swathes of suitable habitats occur in Upper Bhaba Valley, Snow Partridges are uncommon..

Raptors:

Among raptors, Lammergeier and Himalayan Griffon Vulture are the most common species in Rupi-Bhaba WLS; while the former occurs at higher altitudes, Himalayan Griffon is frequently met with up to 3000 m. Golden and Booted Eagles were also frequently seen throughout the Sanctuary. High-altitude raptors like Eurasian Sparrowhawk and Himalayan Buzzard are common in Upper Bhaba valley. Among the falcons, Common Kestrel and Eurasian Hobby are widespread, while Peregrine Falcons could occur along the Sutlej Valley.

Doves & pigeons:

Oriental Turtle-dove is present throughout the Sanctuary and up to 3300 m in Listegarang Valley. Speckled Wood-pigeons were found in small flocks particularly around Shorang Valley. Large flocks of Snow Pigeons were seen at higher altitudes closer to glaciers in Upper Bhaba Valley and Shorang Valley. Several pairs of Wedge-tailed Green Pigeons were sighted at lower altitudes along Salaring and Sutlej valleys.

Owls:

Among owls, Collared Owlet and Mountain Scops-owl were heard throughout the Sanctuary. Asian Barred Owlet was seen and heard at lower altitudes in Rupi and Salaring valleys. One Himalayan Wood-owl was distinctly heard (double-noted deep resonant hoots, quite distinct from Tawny Wood-owl with which it was treated formerly as a subspecies) at Shamno dhar in Rupi valley (2995m).

Though not seen in the survey, Upper Bhaba Valley, Phuphal Ghad valley and Yurang dhar had large tracts of rockfalls and rocky slopes that could hold Eurasian Eagle-owl populations.

It is also quite possible that both Long-eared Owl (*Asio otus*) and Short-eared Owl (*Asio flammeus*) migrate through Sutlej Valley in winter, though it needs to be corroborated.

Swifts:

Rocky cliffs and ridges that typically characterize the mountain gorges and river valleys of Rupi-Bhaba WLS offer a great diversity of habitats for swifts in general. Himalayan Swiftlet is, by far, the most abundant species of swifts in the Sanctuary. White-throated Needletails were frequently encountered along Sutlej valley. Though not seen in the survey, other species like Alpine, Common, and Fork-tailed Swifts could very well occur in Rupi-Bhaba Sanctuary.

Woodpeckers:

Himalayan Woodpecker is the most common species in the Sanctuary, though Scaly-bellied Woodpecker occurs in good numbers in lower Rupi and Salaring valleys. A couple of live nests of the latter were found in Rupi.

Passerines:

As mentioned earlier, birds of dry temperate mixed coniferous forests were numerically the most predominant elements in the birdlife of Rupi-Bhaba WLS. Species like Spotted Nutcracker, Spot-winged Tit, *Phylloscopus* leaf warblers, White-cheeked Nuthatch, Bar-tailed Treecreeper, Mistle Thrush, and Black-and-yellow Grosbeak were the commonest birds that one would encounter throughout the Sanctuary. In particular, the leaf warblers of *Phylloscopus* genus were strikingly conspicuous. The fact that 10 species of *Phylloscopus* warblers occurs in the Sanctuary in good numbers makes it an ideal destination for ornithologists and

birdwatchers. This should get publicized well when ecotourism initiatives are to be taken up as suggested in the management plan. Specifically, occurrence of Large-billed Leaf Warbler along the riverine forests of the Sanctuary and breeding colony of Hume's Leaf Warblers in high-altitude birch forests in Upper Bhaba Valley assumes significance, given the fact that these two species are not common elsewhere in the Western Himalayas. Among the Cettia warblers, Brownish-flanked Bush-warbler is the most abundant species, being found in scrub and shrubberies on the edge of forests and hill-cultivation; On the other hand, Grey-sided Bush-warbler is quite scarce being heard only at Gyare forest near Bhaba valley (3100m) and Khasyan base camp in Listegarang Valley (3050 m).

Our record of White-browed Bush-robin in subalpine birch forests of Bhaba Valley (near Mulling) is a significant range-extension as the species is currently known to occur only from Kumaon in Uttarakhand eastwards. Both Indian Blue Robin and Orange-flanked Bush-robin are quite frequent in the Sanctuary.

Another notable feature of the local avifauna is the high abundance of flycatchers. Breeding of Ultramarine Flycatcher in coniferous forests, Grey-headed Canary Flycatcher in damp ravines and streamside vegetation, Dark-sided Flycatcher in edges of temperate forests and Slaty-blue flycatcher in subalpine scrub are noteworthy in Rupi-Bhaba WLS.

One can also see here two of the most uncommon birds of Western Himalayas, *viz*., White-throated Tit and Long-billed Thrush. While the former occurs in Shorang Valley, the latter is found in dense moist temperate forests of Lankapuri Valley.

Among finches, Fire-fronted Serin, Common Rosefinch, Pink-browed Rosefinch, European Goldfinch, Plain Mountain-Finch, Red-headed Bullfinch, and Black-and-yellow Grosbeak are conspicuous among local avifauna.

Rock Bunting is one of the commonest birds at mid-altitudes throughout the Sanctuary. Interestingly, Chestnut-eared Buntings which are quite uncommon in Western Himalayas were observed to breed along the Sutlej Valley hills.

3.5.1 Management Prescriptions

- An ornithological survey covering all habitat types and seasons should be undertaken to bring out an authoritative checklist of the birds of the sanctuary with population status, habitat occupancy, breeding information, and local movements. The survey task can be assigned to professional organizations like BNHS and ZSI. Necessary permission should be issued for use of mist nets and playback recorders without which bird surveys in mountainous terrains would be incomplete.

- Survey of major nesting caves of the mountain swifts in the sanctuary should be made and regular monitoring of their status should be in place.

- We recommend the following research proposals on birds of Rupi Bhaba Sanctuary, which external organizations can be encouraged to undertake:
  - Use of bird communities as indicators of ecosystem disturbance in temperate forests
  - Impacts of livestock grazing on bird communities of high-altitude alpine scrub
  - Ecological study on sympatric warblers of Rupi-Bhaba Sanctuary
  - Role of birds in regeneration of oak-conifer forests with particular reference to nutcracker, grosbeaks, crossbill, and bullfinches of Rupi Bhaba Sanctuary

3.6 Reptiles and Amphibians

Amphibians and reptiles are key components of many ecological systems. Consistent with the overall decline in biodiversity, amphibian and reptile populations are currently experiencing declines worldwide. The herpetofauna of Himalayan region is one of the least studied ecological assemblages in India owing to its remoteness, extreme weather conditions and availability of a very short time for sampling. Literature in this regard is also very scanty except a few studies done by early colonial pioneers like Gunther,et al., Boulenger, et al. 1907, Annandale, N. 1917 lately some good work had been done by Dubois, Tilak, R. and P. Roy. The herpetofaunal diversity of the Western Himalaya is generally low and unremarkable owing to the unfavorable microclimate prevailing in the high-altitude mountains for these cold-blooded creatures and extreme remoteness of the region. Our short survey revealed the presence of the following three species of amphibians and five species of reptiles, though a comprehensive study would yield a few more species from the Sanctuary.

Amphibians

Himalayan Toad (*Duttaphrynus himalayanus*): The colour of the body is uniform brown, with cranial crest and tips of digits dark brown. Breeding activity starts after the first showers of the monsoon between May-July; males croak in low tone with "curr, curr" repeated several times. Dark pigmented eggs are laid in a double string of jelly in shallow pools along torrents. In Rupi Bhaba Sanctuary, it is very common inhabiting all the warmer lower elevations of the sanctuary till about 2800 m; it is very often seen on bridle paths and in houses during spring and monsoon season.

Beautiful Torrent Frog (*Amolops formosus*): A medium-sized species with a bright green, greenish, or olive dorsum covered with spots. The hind limbs are very long, with complete webbing and adult males have vocal sacs and velvety nuptial pads on the first finger. The frogs live in torrents from 1,700 to 2,650 m in forested and non-forested areas. In Rupi Bhaba Sanctuary, it is common along the warmer parts of Rupi, Chota Kamba, Salaring and Lower Bhaba valleys. It could be readily seen on the boulders and rocks along torrential streams.

Stoliczka's Frog (*Paa vicina*): Head is broader than long and depressed, with nasal openings a little nearer to the eye. This species is very common along the streams of the warmer parts of the Sanctuary. It is generally observed at the bottom of the streams. Breeding commences with the onset of monsoon and continues till September. The tadpoles of this species are remarkably large and could be easily distinguished from those of sympatric species by their size alone.

Reptiles

Kashmir Rock Agama (*Laudakia tuberculata*): Much depressed head with snout longer than the diameter of the orbit and lateral nostrils. Olive-brown above, spotted or speckled with blackish, sometimes with small yellowish spots; the breeding male's throat blue, with light spots and sometimes a light vertebral band. This agamid is common in warmer parts of the mountains, being found in exposed areas like rocky outcrops where they are found basking during the day. It is found between 1500-2500 m altitudes.

Himalayan Ground Skink (*Asymblepharus himalayanus*): Small to medium sized skink with orange red ventral region including the tail and sometimes belly. In Rupi Bhaba Sanctuary, it is commonly seen in stony areas and rocks in coniferous forests till the tree line between 2000 to 3800 m.

Ice Field Skink (*Asymblepharus ladacensis*): A medium sized skink with brown to olive upper body. On the back there are 4 diffuse lines with some dark brown and white specks. A dark brown lateral stripe runs along the neck and the flanks and is bordered by whitish colour at the top. The ventral part is steel blue in colour. It is generally found in alpine meadows above the tree line, where it is very common; it is also seen up to an elevation of 6000 m (highest altitude so far reported for any cold-blooded vertebrate).

Himalayan Keelback (*Amphiesma platyceps*): Olive-brown above with small prominent black spots; frequently two black parallel lines or an elliptic marking on the nape; a light, black-edged streak on each side of the head, or a black line from eye to gape;

belly yellowish, with or without blackish dots; often a black line or series of elongate blackish spots along each side of the belly; lower surface of tail frequently mottled with blackish. In life, a coral-red band is said to run along the ends of the ventrals. In Rupi Bhaba Sanctuary, it is generally seen along the streams and rarely in pine forests between 2000 and 3600m.

Himalayan Pit Viper (*Gloydius himalayanus*): Medium-sized snake, with distinctly elongated and triangular head and a prominent pit between eye and nostril. The upper body varies in color from light brown or gray to dark brown. A median series of dark brown blotches, alternating with lateral row of spots; a broad dark band from eye to the angle of mouth. The undersides are light gray with dark clouding and fine spotting. This snake frequents rocky wooded hill sides, where it lives in caverns and crevices among rocks. It hibernates in winter from October to April. Though it tends to bask in bright sunny winter days, the snake is habitually sluggish. In the sanctuary, it is fairly common between 1500 to 2500 m.

3.6.1 Management Prescriptions

Although we currently lack detailed knowledge of specific habitat requirements for many of the Western Himalayan herpetofaunal species and the impacts of various anthropogenic activities, this lack of knowledge should not deter us from making common decisions:

- A complete inventory of herpetofauna of the sanctuary should be prepared after comprehensive surveys in the field. Professional organizations should be roped in to conduct these surveys.
- Formal research should be undertaken to study the impacts of pesticides, water impoundments, habitat fragmentation, and roads on reptiles and amphibians of the sanctuary.
- Water impoundments should not be constructed in key amphibian habitats (small spring water streams) which would disturb and flood key breeding habitats of many amphibians.
- Application of herbicides and pesticides should be minimal in cultivations in and around the buffer zone of the Sanctuary since they directly affect breeding, foraging and larval ecology of most amphibians.

3.7 Invertebrates

There is no document or information available on invertebrate fauna of Rupi Bhaba Sanctuary, and it is presumably similar to other parts of the Western Himalaya.

3.7.1 Management Prescriptions

- Since the Himalayas are rich in species diversity of endemic invertebrates, it becomes imperative that a detailed survey be conducted in Rupi Bhaba Sanctuary to develop a basic inventory. Organizations like ZSI can be approached for this purpose. As invertebrate survey would necessarily incur invasive techniques like trapping, collection, and preservation of specimens for positive identification, Forest Department should offer the survey teams all the required facilities like permission from the Chief Wildlife Warden's office and field-logistics. Select specimens from these collections can be displayed with relevant ecological information in the Nature Interpretation Centre proposed in the Sanctuary by this management plan.

3.8 Endemic and Threatened Species

The degree of endemism in the wild fauna of a landscape depends on its area of extent and geographical isolation and taxa. For example, an oceanic island will have more endemic species in comparison to mainland, and smaller, less itinerant taxa will be characterized by higher degree of endemism. This general biogeographic principle is also reflected in the endemicity of Himalayan fauna.

Among the 65 species of mammals of Rupi Bhaba Sanctuary, only two (Himalayan Tahr and Royle's Mountain Vole) are truly endemic to the Himalaya. And among the 200 and odd species of birds found in the sanctuary, only five species (i.e., Western Tragopan, Cheer Pheasant, White-throated Tit, Tickell's Thrush, and Pink-browed Rosefinch) are restricted to the Himalayas in their distribution. On the contrary, two out of three species of amphibians recorded in the Sanctuary (i.e., *Duttaphrynus himalayanus* and *Paa vicina*) and four out of five species of reptiles found in the sanctuary (i.e., Kashmir Rock Agama, Himalayan Ground Skink, Ice Field Skink, and Himalayan Pit Viper) are endemic to the Himalaya.

According to IUCN Red List of Threatened Taxa, three species of mammals in Rupi Bhaba Sanctuary are currently threatened with one endangered species [Snow Leopard] and two others categorized as vulnerable [i.e., Asiatic Black Bear and

Himalayan Tahr]. Among the avifauna found in the Sanctuary, three species are assessed as vulnerable [i.e., Western Tragopan, Cheer Pheasant, and Wood Snipe].

Among the plants found in the sanctuary, 9 species are categorized by IUCN as globally threatened, with one species evaluated as endangered (*Saussurea costus*) and others as Vulnerable (e.g. *Acer caesium*, *Aconitum falconeri*, and *Carex munroi*).

3.8.1 Management Prescriptions

- Though amphibians and reptiles are represented by very few species in Rupi Bhaba Sanctuary, they show a remarkable degree of endemism warranting high priority of protection. The management recommendations suggested under the section dealing with the herpetofauna in the current Plan should be adopted without any delay.
- The endemic and globally threatened species of the sanctuary should be studied in detail and species-specific conservation measures should be implemented along with habitat protection. In particular, the remaining ranges of grass-and-scrub covered hills and ridges along the Sutlej Valley (buffer zone) should be guarded against expansion of crop-fields to protect the last surviving population of Cheer Pheasants in the sanctuary.

3.9 Ecological Indicators and Keystone Species

Any plant or animal or group of organisms indicative of a particular environment or set of environmental conditions is termed an 'ecological indicator'. The concept of ecological indicators assumes a greater significance in Protected Area management, as it enables us to assess the status of ecosystems and identify problems prior to a crisis (Canterbury et al., 2000). An ideal indicator species should be acutely sensitive to changes in ecosystems and human disturbance, should be well-known biologically, should be easily sampled or observed, should be smaller in body size, and should breed locally. A keystone species is one whose removal could lead to often irreversible changes in population structure of other species either directly or mediated through habitat modifications. Identification of keystone species in an environment is important as the management would then be able to pay special attention to them so that the entire set of species assemblages and habitat matrix associated with the keystone species are benefited from the focus. The indicator and the keystone species may not necessarily be same in an ecosystem, though both are useful tools in conservation practice and PA management.

It is true that identification of ecological indicators or keystone species generally follows extensive research often involving long-term monitoring. In the absence of such systematic studies in Rupi Bhaba Sanctuary, we can venture some generalized indications on the basis of our collective knowledge gained from studies in other parts of the Western Himalaya and natural history observations. Some of the important keystone species of different habitats / ecosystems in Rupi Bhaba Sanctuary include the following (Table 8).

Table 8. Major keystone species that require management intervention for protection in Rupi Bhaba Sanctuary.

Keystone species	**Habitat / Ecosystem**	**Ecological Significance**
Himalayan Weasel	High-altitude coniferous forests and alpine meadows	Checks populations of small mammals like rodents and pikas at high altitudes; Uncontrolled, these herbivorous prey species would damage the fragile alpine ecosystem.
Bharal (Blue Sheep)	Mountain ridges and open grassy alpine meadows	Major wild prey for Snow Leopards in summer.
Himalayan Monal	Montane temperate broadleaved-conifer mixed forests with alpine pastures	Aids regeneration of oak saplings which readily germinate from parts of earth dug out by the Monals while feeding.
Himalayan Griffon & Lammergeier	High-altitude mountains	Most efficient scavengers of the mountains; while the former feeds on flesh of the carcass, the latter disposes of the remaining bones and skeletons.
Oaks (*Quercus* spp.)	Broadleaved temperate forests and mixed conifers	Leaves are important food for several species like Western Tragopan and Giant Flying Squirrels and preferred fodder for mountain livestock. The acorns are major food for birds like nutcrackers, jays, and grosbeaks

Many species in Himalaya are habitat-specialists and therefore serve as indicators of the viability of the respective habitats. For example, presence of

Himalayan Musk Deer is often hailed as a sign of healthy, undisturbed oak-rhododendron temperate forests. Similarly, a good population of pikas in alpine meadows indicates the general well-being of the ecosystem.

Mammals like Himalayan Water Shrew and bird species including Brown and White-breasted Dippers, White-capped and Plumbeous Water Redstarts, and Little and Spotted Forktail are excellent indicators of the undisturbed high-altitude rocky hill-streams and torrents. These montane hill-streams are unique to the Himalayas and are also home to montane invertebrate communities. These species often avoid those stretches of the streams that suffer from persistent level of disturbance from livestock and human activities.

Bird species like Woodcock and Solitary Snipe occur only in undisturbed marshy and boggy glades in dense montane forests, and as such, their presence signifies the nearly intact nature of the montane ecosystem. On the other hand, some species are harbingers of extreme habitat modifications; for example, Black Francolin, a bird of the foothills and plains has recently colonized the cultivated hills of Sutlej Valley.

Invasive weedy growth of certain plants like *Lantana camara* (along Sutlej Valley up to 1500 m), *Eupatorium odoratum* (1500 – 2800 m), and *Anemone* spp. and *Rumex* spp. (alpine meadows and pastures above tree line) indicate high degree of disturbance in the form of canopy openings, vegetation clearing, and livestock grazing.

3.9.1 Management Prescriptions

- Adequate research is required to identify keystone species of different habitats in Rupi Bhaba Sanctuary and to ascertain taxa which indicate human-induced changes in the immediate environment in a short span of time.
- Taxa which have been identified as such need utmost protection from the management and regular monitoring of their populations in the sanctuary should be part of the management protocol. In particular, populations of vultures, pheasants, mustelids, and mountain ungulates are to receive special attention.
- Observations of sudden decline in local populations of these keystone and indicator species or instances of their absence from seemingly suitable habitats should be investigated to find out the reasons and mitigatory measures should be undertaken to eliminate the damaging factors and bring back the populations.

- Colonization of weeds should be prevented at all cost from the sanctuary and root causes for their infestation should be identified and removed after the eradication of weeds. For example, proliferation of *Anemone* spp. and *Rumex* spp. in alpine meadows will cease once the grazing practices are regulated and staggered.

3.10 Animal-Habitat Associations

Habitat of a species refers to its living space which can be characterized by a specific set of physical factors and biotic components. In the strictest sense, a habitat is always species-specific. But for all practical purposes, every distinct vegetation type or landform is generally described as a wildlife habitat common to a given assemblage of multiple species living therein. This rather broad working definition of habitat allows us to consider the habitat requirements of a majority of species in adequate terms in a management plan, and fine-scale habitat recommendations can then be easily tuned in to the needs of select species.

Rupi Bhaba Sanctuary, in view of its wide elevational range, is endowed with a great diversity of vegetation types and wildlife habitats, some of which are unique and hold several habitat-specialists. The following table (Table 9) summarizes some of the noteworthy cases of animal-habitat associations in the Sanctuary.

Table 9. Animal-habitat associations in Rupi Bhaba Wildlife Sanctuary

Sl. No.	Habitat type	Characteristic species
1.	Temperate coniferous forests (pine+spruce+fir+deodar)	Cone-feeding birds like Nutcrackers, Grosbeaks, Crossbills, and Jays
2.	Mature oak-conifer forests	Red Giant Flying Squirrel
3.	Oak-rhododendron forests interspersed with grassy glades and pastures	Himalayan Musk Deer, Yellow-throated Marten, Indian Blue Robin, and Variegated Laughingthrush
4.	Old growth forests of oak-spruce-fir with ringal undergrowth	Western Tragopan, Koklass Pheasant, and Himalayan Wood Owl
5.	Densely forested deep gorges and valleys	Serow
6.	Grass-and-scrub covered cliffs and ridges of lower Himalaya	Goral, Cheer Pheasant, and Chestnut-eared Bunting
7.	Sub-alpine stunted birch forest	Hume's Warbler
8.	Alpine scrub near tree line	Himalayan Brown Bear, Tickell's Warbler, Buff-barred Warbler, Blue-fronted Redstart, and White-tailed Rubythroat,
9.	Alpine meadow and stony pastures close to snowline	Pikas, Himalayan Weasel, Snow Partridge, and Himalayan Monal,
10.	Open grassy boulder-strewn	Snow Leopard, Bharal (Blue sheep), and

Sl. No.	Habitat type	Characteristic species
	cliffs and alpine pastures above tree line	Himalayan Snowcock
11.	Rocky hill-streams and montane torrents	Himalayan Water Shrew, Dippers, Water Restarts, and Forktails
12.	Dense riverine and stream-bank vegetation in interior valleys	Long-billed Thrush, Grey-headed Canary Flycatcher, and Large-billed Leaf Warbler
13.	Alpine caves	Bats and Swifts

3.10.1 Management Prescriptions

- A detailed survey should be carried out to elucidate specific habitat requirements of key species in Rupi Bhaba Sanctuary and their associated faunal elements. This should be followed up with mapping of available habitats in the sanctuary for each species using GPS aided ground surveys and remote sensing imageries of land cover/use patterns. These maps will go a long way towards evolving long-term population and habitat monitoring protocol for threatened fauna.

3.11 Assessment of Habitat Suitability for Key Species

Once the key habitats are identified, they should be assessed for their suitability to host viable population of the species concerned. This is important as wildlife habitats are constantly under threat from a slew of external pressures, and even an elementary assessment would help the management to take corrective actions in time. Though habitats can be assessed by several ways [among which Habitat Suitability Index (HSI) models are quite popular], these methods require long-term data on demographic variables and productivity. In the absence of such data from Rupi Bhaba Sanctuary, we rely upon our first-hand observations from our survey to make some preliminary appraisals on the current status of habitats for some key fauna.

Snow Leopard: The open grassy boulder-strewn cliffs and alpine pastures above tree line form the core habitat for this topmost predator of high altitudes. In Upper Bhaba Valley, the stronghold of Snow Leopard in the Sanctuary, the habitats seem to be viable, though population of wild preys are in short supply forcing the predator to seek livestock in summer.

Asiatic Black Bear: It primarily thrives in dense vegetation of temperate forests in rocky valleys. The habitats are marginally well-protected in Salaring Valley and interior parts of Lankapuri and Phupal Gad valleys. But these do suffer from

anthropogenic disturbances like the collection of *guchchi* mushroom during monsoon and movement of livestock in summer.

Himalayan Musk Deer: Mature oak-rhododendron forests with glades of pastures make up the primary habitat for Musk Deer. Despite the fact that these habitats do occur in all the valleys of the Sanctuary, heavy degree of disturbance marks a majority of these sites. Even in places where habitats seem to be relatively better, indiscriminate hunting in the recent past (for musk pods) made even these habitats suboptimal.

Goral: Though extensive areas of its habitat (grass-and scrub covered hills and ridges with steep cliffs) are available esp. along the Sutlej Valley and downstream gorges of its tributaries like Shorang and Salaring, these habitats are heavily disturbed and in a degraded state. In the interior valleys of Lankapuri, one could see relatively.

Himalayan Serow: The densely forested deep narrow mountain gorges and ravines, owing to their terrain, are, for a large part, free from human disturbances. Serow, being primarily the denizen of such interior forested valleys, therefore enjoys much protection and its habitats also seem to be largely undisturbed.

Himalayan Tahr: It inhabits steep precipitous cliffs with good grass and forest cover. Though several cliffs hold localized populations of Himalayan Tahr in the interior valleys of Shorang, Salaring, and Lankapuri, heavy poaching (at least till recent past) has made these habitats no longer viable for the species. During summer, livestock also compete for the same resources as that of the Tahr, and it is usually the latter which retreat from the stiff competition.

Western Tragopan: The old-growth forests of oak-conifer (mainly spruce & fir) with dense ringal undergrowth on steep slopes are the prime habitat for the endangered Western Tragopan populations. These mature forests still survive in parts of the sanctuary, holding up significant populations of Western Tragopan. In particular, the habitats in Shorang and Salaring (Lankapuri) valleys are in good condition and are relatively less disturbed. On the contrary, Tragopans are absent from the old-growth forests around Shamno Dhar in Rupi valley, probably owing to heavy disturbance.

Cheer Pheasant: It prefers early successional habitats like grass-and-scrub covered hillsides. Though these habitats were plenty along the Sutlej Valley in the past, these hill-slopes have since been converted to crop-fields depriving the Cheer Pheasants of their original habitats. The only remaining habitats that exist in Salaring valley and Nathpa also suffer from heavy degree of disturbance.

Eurasian Woodcock: The marshy bogs and glades amidst dense patches of temperate montane forests are paramount breeding and foraging grounds for this shy and rare bird of the high Himalayas. Structurally intact, undisturbed patches of such forested glades can be seen in Shamno Dhar, Phupal Gad, and Bhaba valleys.

3.11.1 Management Prescriptions

- The habitat suitability of key species of conservation significance should be regularly evaluated against standard norms and requirements, which can be built on the basis of published research literature. An easy-to-do protocol for rapid assessment of wildlife habitats may be developed with the aid of organizations like Wildlife Institute of India, and the frontline forest staff can be trained to carry out this exercise.
- The fact that wildlife populations still manage to hold out against all odds means that they can recover even if some small concrete steps are taken to make their habitats viable. For example, regulation of temporary livestock camps in Shamno Dhar would make the Musk Deer population to bounce back in Rupi Valley.

3.12 Threats to Wildlife Habitats

A major problem in wildlife conservation, apart from poaching, pertains to external threats to their habitats. Since a large number of species are habitat specialists and sensitive to disturbances, any factor that endangers the structural and ecological integrity of habitats would be detrimental to wildlife populations in the long run. At times, some of these threats may take alarming dimensions in a very short time wiping out the local populations.

During our survey and interactions with the forest department field-staff, we identified the following as major threats to wildlife in Rupi Bhaba Sanctuary.

Livestock grazing: The higher reaches of Rupi Bhaba Sanctuary are characterized by large number of alpine pastures and meadows, to where livestock are taken for grazing in huge numbers every summer. These temporary shepherd camps (locally known as *dogri*) and semi-permanent camps with a single season crop-raising around the camp (*thatch*) take over much of the pristine wildlife habitats inside the sanctuary. In particular, species such as Himalayan Tahr, Musk Deer, Brown Bear, and Bharal which use the alpine meadows for foraging are severely affected. Further, movement of thousands of livestock through the forested trails inside the Sanctuary causes enormous damage to vegetation besides aiding dispersal of invasive weeds.

Forest fire: Forest fires are common in Rupi Bhaba Sanctuary in early summer and temperate coniferous forests are particularly vulnerable. Old-growth spruce-fir forests with bamboo undergrowth, which are the primary habitats for Western Tragopan, are frequently prone to forest fires. Though these fires are generally limited to ground and middle-canopy, habitats take inordinately longer time to recover. In addition, the undergrowth is sometimes a vital component of the habitat requirements of a species (e.g. ringal bamboo for Western Tragopan). These fires also destroy the standing stumps of old dead trees (esp. conifers like spruce, fir and deodar) which otherwise offer key nesting sites for cavity-nesting bird species like owls, barbets, woodpeckers, and nuthatches.

Invasion of weeds: Invasive growth of weeds (both exotic and native) is a persistent problem in management of wildlife habitats. In Rupi Bhaba Sanctuary, weeds like *Lantana camara* in the lower Himalayas along Sutlej Valley, *Eupatorium* spp. in middle altitudes, and *Rumex* spp. and *Anemone* spp. at high-altitude alpine pastures pose threats to habitat composition. The nomadic livestock moving inside the sanctuary are often the primary source for colonization of these weeds. Anthropogenic activities that clear up undergrowth of native vegetation and overgrazing of select palatable species of herbs and grasses by livestock in alpine pastures are the key factors for invasion of weeds in wildlife habitats.

Wood cutting: Felling of trees for timber affects the habitat quality by opening up the canopy and through secondary disturbance brought by movement of humans. Since the ban on traditional rights of local people for timber to be used in building purposes came to effect in 2003, instances of illegal wood-cutting have been on an increase in the sanctuary. This has put enormous pressure on oak-pine and deodar forests close to villages and species like Yellow-throated Marten, Red Giant Flying Squirrel, and Koklass Pheasant suffer a significant loss of their habitats.

Collection of NTFPs: In Rupi Bhaba Sanctuary, local people visit interior mountain valleys that form wildlife core areas for collecting commercially valuable non-timber forest products like ringal bamboo (*Arundinaria falcata*), *guchchi* mushroom, and medicinal plants (e.g., dhoop stick, bankakri, tallish patra, karu, hath-panja, and patish). The gathering of a large number of people in a small area (more prominent during *guchchi* collection in monsoons) causes a lot of disturbance to the habitats and wildlife populations.

Infrastructural development: Though there is currently very little infrastructure work inside the core area of the Sanctuary, developments like construction of pucca roads (Bhaba Valley) and mini hydro-electric projects (Bhaba Valley and Salaring Valley) do cause damage to wildlife habitats in the buffer zone. The recent eco-

tourism initiatives in Bhaba Valley need to be watched out for any of their negative impacts on wildlife habitats.

3.12.1 Management Prescriptions

- The current and potential threats to wildlife habitats in the sanctuary should be identified and thoroughly investigated to find out ways and means of mitigating them. Some of the urgent measures are, however, warranted to stave off the general threats and these include overseeing of livestock grazing and regulation of shepherd camps, monitoring of forest fires, prevention and eradication of invasive weed growth, deregulation of traditional timber distribution rights, and streamlining the process of collection and marketing of NTFPs. [Please refer to Chapter 5 and 6 for detailed accounts of these management prescriptions]. Any future infrastructural development work inside the sanctuary limits including that of ecotourism camps should be preceded by a thorough examination of their possible impacts on wildlife habitats and populations.
- Fire management strategy should involve identification of sites where fire is a recurring problem. This can be mapped using GIS. Local people needs to be included in the fire management as informers and also in helping to extinguish the fire. Regulated burning can also be implemented to prevent unwarranted fire regime. A dedicated 'fire squad' needs to be set up within the PA, and this team would have to be trained on professional fire management strategy. Water tanks, water pipes and carbon dioxide fire suppression system are some of the support facility are required to manage forest fires.

3.13 Ecosystem and Economic Services

Ecological and socio-economic value of goods and services provided by natural and semi-natural ecosystems are integral to the purpose of creating Protected Areas. These can be grouped into four key ecological functions (following de Groot et al., 2002) *viz*., (1) regulation (e.g., climate mitigation, water regulation, soil formation and retention, nutrient regulation, pollination, and biological control), (2) habitat (for wildlife), (3) production (of food, raw materials, genetic materials, and medicinal resources), and (4) information function (e.g., recreation, spiritual and cultural values and information, and science and education).

In this regard, some of the key ecosystem goods and functions derived from forests and faunal components of Rupi Bhaba Sanctuary are listed below:

Regulation functions:

Glaciers that dot the northern reaches of higher Himalaya [in Shorang, Salaring, and Bhaba Valleys] are protected from agents of climate change; these glaciers and catchments of Himalayan rivers ensure water security for downstream communities and plains. The natural vegetation and drainage safeguard the top soil from erosion, thus maintaining the soil fertility and edaphic profile. For example, *Alnus nipalensis* (kunees) trees that naturally form pure stands along riverine spits in Salaring valley are known for their nitrogen fixing properties and as a remedy for stabilizing eroded soils. Natural processes inside the forests like decomposition, fire, grazing, and trophic cycles aid to keep the vital nutrient cycles intact and protect them from positive feedbacks that break the energy flows. Several species of fauna (like insects, birds, and bats) help in pollination and dispersal of plants, thereby maintaining regeneration of forests and also crop productivity. Predators like mustelids, owls, and snakes help control the rodent populations, and several species of insectivorous bats and birds keep the insect populations in check.

Habitat functions:

Mention has already been made as to the role of natural vegetation and distinct landforms in serving as key habitats for wild fauna. There are also unique wildlife habitats like mountain caves, snags, rock falls, torrents, tree canopy, and subterranean root system that are used by some select species.

Production functions:

The forests in the buffer zone meet the timber and fuel wood requirements of local communities. Several valuable medicinal plants like *Jurinea macrocephalla*, *Podophyllum hexandrum*, *Picrorhiza kurrooa*, *Saussurea obvallata*, and *Aconitum heterophyllum* are obtained from the forests. The *guchchi*, a commercially valuable mushroom is a major NTFP sourced out from the forest floor of the sanctuary.

Information functions:

Rupi Bhaba Sanctuary offers some of the best opportunities for scientific research in ecology and wildlife management. For example, the high abundance in the sanctuary of otherwise rare species like Serow and Red Giant Flying Squirrel makes it an ideal site for studying their ecology. Bhaba Valley with its scenic landscape is a popular trekking route for general and adventure tourists; similarly trek from Chota Kamba to Yurang Dhar offers some of the best wildlife viewing for trekkers. There are

a few sites inside the limits of the sanctuary which are considered sacred by the local communities. These include Pandoswar Peak in Listegarang Valley, Shiv Ling spur above Mulling pasture in Bhaba Valley, and Nag devta ridge in downstream Phupal Gad.

3.13.1 Management Prescriptions

- The vital ecological functions of Rupi Bhaba Sanctuary along with the goods and services it offer should be publicized well in local language to garner political will and public support for the sanctuary. These information should be displayed with illustrated examples in the Nature Interpretation Centre proposed under this Management Plan.
- Emphasis should be given as to how these ecological goods and services benefit the lives of people and boost the economic value of forests in general.
- A specific assignment could be given to universities and research organizations to study the ecological and economic goods and services derived from the sanctuary.

Chapter 4. Population of Key Species: Status and Threats

4.1 Large Mammals

We conducted, as part of the management plan, a rapid field-survey of population status and threats of major mammals in Rupi Bhaba Sanctuary between April and June in 2008. The surveys did not attempt to count the animals nor their density estimates and were limited to encounter rates in terms of frequency of occurrence of direct sightings or indirect evidences along select treks and trails. A summary of the survey results is given in Table 10, and detailed species-wise assessments are provided in the Appendix 11. Since the surveys lacked spatial and temporal replicates, the results are only indicative in nature and may not reflect true density patterns of the mammal populations.

Table 10. Summary of survey trails, their length, altitudinal limits, and major mammalian fauna encountered therein.

Survey route	Valley	Length (km)	Altitudinal range (m)	Mammals with significant populations
Rupi FRH to Gaukanda Dhar	Rupi	3	2450 - 2875	Goral, Common Leopard, & Giant Flying Squirrel
Rupi FRH to Shāmno Dhar	Rupi	4	2370 - 2900	Goral & Giant Flying Squirrel
Around Shāmno Dhar	Rupi	2	2930 - 3035	Musk Deer, Goral, Black Bear, Common Leopard, & Giant Flying Squirrel
Shāmno Camp to Taé Dhar	Rupi	2.5	2900 - 3200	Musk Deer, Black Bear, Leopard Cat, Common Leopard, & Giant Flying Squirrel
Rupi to Dumti (Shorang Valley)	Shorang	13	2500 - 3070	Common Langur, Musk Deer, Serow, Black Bear, Leopard Cat, & Common Leopard
Dumti to Muglāng Aag Thatch along Kumrang	Shorang	2	2700 - 3240	Musk Deer, Goral, Red Fox, Leopard Cat, & Common Leopard
Dumti to Deiya Thatch along Shorang	Shorang	2.5	2700 - 3200	Common Langur, Musk Deer, Himalayan Tahr, & Common Leopard
Dumti to Chota Kamba	Shorang	11	2300 - 2700	Serow, Common Leopard, & Yellow-throated Marten

Survey route	Valley	Length (km)	Altitudinal range (m)	Mammals with significant populations
Chota Kamba to Shāl Thatch (Base of Yurang Dhar)	Shorang	3	2100 - 3180	Musk Deer, Goral, Black Bear, Common Leopard, & Yellow-throated Marten
Shāl Thatch to Yurang Dhar	Shorang	1.2	3200 - 3800	Himalayan Weasel
Chota Kamba to Salaring FRH	Salaring	5	1800 - 2130	Jackal & Yellow-throated Marten
Salaring FRH to Lankapuri Valley (Bāling Sow Camp)	Salaring	4	1850 - 2450	Common Langur, Goral, Serow, Black Bear, & Common Leopard
Bāling Sow camp to Kimpo-Kyalā Dhar (Lankapuri)	Salaring	2	2480 - 2635	Common Langur, Goral, Himalayan Tahr, Musk Deer, Serow, Black Bear, Yellow-throated Marten, Leopard Cat, & Common Leopard
Bāling Sow camp to Tū Shāng dhar and Lankapuri Ridge	Salaring	1.5	2550 - 2720	Common Langur, Himalayan Tahr, Musk Deer, Serow, Black Bear, Yellow-throated Marten, & Common Leopard
Salaring village to Lower Phuphal Ghad Valley	Salaring	1.8	1800 - 2225	Serow, Goral, Black Bear, Leopard Cat, & Common Leopard
Katgaon to Mulling (Bhaba valley)	Bhaba	13	2430 - 3260	Musk Deer & Leopard Cat
Mulling to Déyā Glacier (Upper Bhaba)	Bhaba	4.5	3260 - 3500	Musk Deer, Brown Bear, Red Fox, & Snow Leopard
Mulling basecamp to Mulling birch forest	Bhaba	3	3263 - 3295	Brown Bear & Snow Leopard
Mulling basecamp to Kara Pasture (Upper Bhaba)	Bhaba	5	3260 - 3605	Brown Bear, Red Fox, & Snow Leopard
Katgaon to Listegarang basecamp	Listerang	5	2344 - 3011	Common Langur, Musk Deer, Black Bear & Common Leopard
Listegarang camp (Khasyan) to Pandoshwar Meadows	Listerang	2	3025 - 3423	Common Langur, Musk Deer, Himalayan Tahr, Black Bear & Common Leopard

Common Leopard: A very common predator of Rupi Bhaba Sanctuary, Common Leopard thrives well owing to its adaptive nature. In particular, it is abundant in

Shamno Dhar (Rupi Valley), Dumti, Talpo, and Dae cham (Shorang Valley), Shal thatch (near Yurang Dhar), Lankapuri and Phupal Gad valleys (Salaring catchments), and Listegarang Valley up to Pandoshwar. It is even found at higher altitudes up to 3100 m in Bhaba Valley, where Snow Leopards are known to occur. Owing to paucity of wild prey (mainly goral and langurs), the leopards often take livestock from villages and nomadic shepherd camps. This issue is rampant in Salaring valley, and locals demand compensation for livestock loss even outside the core area.

Snow Leopard: A common predator that replaces Common Leopard at higher altitudes above tree line (3200 m). Though we found ample evidences for its occurrence only in Upper Bhaba Valley (Mulling, Kara, and Deiya Pastures), their presence in similar habitats in alpine pastures near the headwaters of Phupal Gad and Pandoshwar meadows cannot be ruled out. Its main wild prey Bharal is extremely low in numbers, and Snow Leopards are therefore forced to take livestock (often large cattle) from alpine grazing grounds in summer. In winter, they are known to descend to lower altitudes in Bhaba Valley (e.g., Homte, Yangpa, and Kafnoo) where the villagers claim that they lift livestock from cattle-pens. But this information is not corroborated by the Forest Department records.

Yellow-throated Marten: Though it is not a large mammal, its role as an important predator of small to medium-sized animals in temperate coniferous forests of the sanctuary is significant for the management. It is quite common throughout the sanctuary with good populations recorded in Rupi, Shorang (Chota Kamba-Shal thatch-Yurang Dhar) and Salaring (Lankapuri) valleys and in Bhaba Valley. Frequently seen around villages in the buffer zone.

Asiatic Black Bear: This large carnivore is feared by locals as it is known to stray into villages and human habitations in search of food and maul humans on close encounters. The instances of human-bear conflicts are notably high in Salaring Valley and Sak Nathpa Beat during winter. Though it occurs in good numbers around all the interior valleys and mountain gorges of the sanctuary, it is particularly abundant in Lankapuri and Phupal Gad catchments and in Listegarang Valley.

Himalayan Brown Bear: Though not as common or ferocious as its congener, Brown Bear occurs in fairly good numbers in high-altitude alpine pastures and scrub well above tree line (> 3400 m). Though we recorded evidences for its presence only from Upper Bhaba Valley, it possibly occurs in alpine pastures in other river valleys as well. Shepherds claim that Brown Bears occasionally lift goats and sheep from their camps in alpine meadows during summer.

Himalayan Musk Deer: Though extensive areas of its habitat are available in the interior valleys and ridges, its population is alarmingly low in the sanctuary. Apparently, the musk deer was heavily poached for its musk pod till the recent past and re-notification of sanctuary in 1990s and subsequent increase in vigil against hunting and commissioning of hydel projects along Sutlej which created employment opportunities for the local poachers have dramatically reduced the pressure. They are now found sparsely throughout the sanctuary, and good populations can still be seen in deep interior valleys of Lankapuri and Bhaba Valley (Deiya glacier).

Goral: Once found in abundance around steep rocky ridges of outer Himalayas along the main Sutlej Valley, Gorals are now reduced to small isolated populations which hold out against all odds in Rupi, Shorang, and Salaring Valleys. Heavy hunting in the past has led to its current status. The only viable populations exist in inner ridges like Yurang Dhar and those that overlook Lankapuri and lower Phupal Gad nallas. In Lankapuri, Gorals are often taken by Common Leopards.

Himalayan Serow: A rare wild ungulate in the Western Himalaya, Serow is surprisingly common in densely forested mountain gorges and narrow deep valleys of Rupi Bhaba Sanctuary. We found frequent evidences for its presence in inner valleys of Shorang and Salaring (Lankapuri and Phupal Gad). Its general resemblance to cattle in appearance and stature might be the reason why Serows were spared by poachers in the past.

Himalayan Tahr: A wild goat of the steep and craggy cliffs, Himalayan Tahr is apparently historically low in numbers in the sanctuary. It is now seen in a few isolated populations in Upper Shorang Valley (Deiya Thatch, Yanger, and Garsurang), Lankapuri catchment in Salaring Valley, and Khasyan to Pandoshwar pasture in Listegarang headwaters. Its reported presence in Dumti and Kumrang Gad ridges, Yurang Dhar, and upper Bhaba Valley needs to be corroborated.

Bharal (Blue Sheep): The main wild prey of Snow Leopards, Bharal occurs in deep interior valleys and glaciers of Upper Bhaba Valley. Said to be sighted commonly in Mulling and Kara pastures a decade back, they have since retreated further into inner valleys owing to grazing pressure from goats and sheep which ascend the alpine pastures in huge numbers every summer. Overgrazing by livestock has also resulted in predominance of unpalatable species like *Rumex* spp. and *Anemone* spp. and this has further alienated the Bharal populations from these pastures. They have also been sighted reliably from Pandoshwar (Listegarang Valley) and Kumrang thatches (Shorang Valley) in the recent past.

Besides, presence of Asiatic Ibex from the limits of Rupi Bhaba Sanctuary has always been a matter of conjecture, as no reliable information exists. Since a good population of Ibex thrives in the neighbouring Pin Valley National Park, it is widely believed to occur in parts of Upper Bhaba Valley contiguous with the Pin Valley in the north. The fact that these interior valleys are virtually inaccessible and habitats also seem to be ideal, it is quite likely that a small population of Ibex is resident in these cliffs.

4.1.1 Management Prescriptions

- It is clear from these observations that poaching and unregulated livestock grazing are the two major threats to populations of large mammals in Rupi Bhaba Sanctuary. Though poaching is now said to be under control inside the Sanctuary limits, sporadic instances are still being reported. A constant vigil is required to prevent recurrence of the poaching camps. But the management of the sanctuary is ill-equipped and understaffed to counter the threats of poaching. The harsh terrain makes patrolling very difficult. We strongly recommend that a dedicated and trained team and anti-poaching camps be constituted at the Range level and may work under the leadership of Forest Block Officer. This team should be provided with all the necessary logistics and infrastructure including arms for self-defence. The Beat Officers should develop a good network of informants and efforts to build reliable intelligence for the sanctuary are to be taken at the earliest.
- Though the management periodically issues license as an effort to regulate number of livestock camps to be allowed to alpine pastures for grazing, the sheer volume of these grazing camps means that it is not possible for the management to oversee their movements with its present state of manpower and logistic resources. A comprehensive policy and work-plan need to be developed to regulate these livestock camps and they should be followed up with the required measures to strengthen the administration with all the necessary resources.
- Regular seasonal monitoring of mammal populations should be done by undertaking encounter-rate surveys along specified trails marked for the purpose. The forest dept personnel may be trained in this regard by experts from Wildlife Institute of India, Dehradun.

4.2 Galliformes and Raptors

During our mammal survey between April and June 2008, we also carried out census of major Galliformes (snowcocks, pheasants & partridges) species using a combination of methods including call-counts and flush-counts. Since our census lacks spatial and temporal replicates, we derived only the encounter rate [number of individuals per species per km] and not actual density estimate. See Appendix 9. for a detailed account of the results of this encounter survey in each of the trails covered.

Himalayan Snowcock: Recorded only from high-altitude stony alpine plateaus of Yurang Dhar in Shorang Valley [Encounter Rate, ER=1.67/km] and Upper Bhaba Valley [ER=1.33], Himalayan Snowcocks are not uncommon in suitable habitats. Mostly heard than seen. Quite sensitive to human disturbances and presence of livestock.

Chukar Partridge: Though the locals claim that it is very common throughout the Sanctuary, we found them only from select parts like Yurang Dhar [ER=3.33], Chota Kamba to Salaring Valley [ER=1.20], and lower Bhaba and Listegarang Valleys [ER=0.88]. We suspect that heavy poaching at least in the recent past could be the reason for their low population currently recorded.

Black Francolin: Essentially a bird of the foothills and plains, it is increasingly expanding its range northwards into outer Himalayas owing to extensive habitat modifications. In the Sanctuary, we came across a few individuals in the buffer zone of Shorang and Salaring valleys [ER=0.60] where erstwhile grass-and-scrub covered hill-slopes and ridges (typical Cheer habitats) have been converted into cultivation and fallows. That Black Francolin colonizes the Sanctuary at the cost of Cheer Pheasant, an endemic and globally vulnerable species, is a cause for concern for the management.

Western Tragopan: The flagship species of wildlife conservation in the North-western Himalayas, the Western Tragopan is locally known as 'jujurana'. Rupi Bhaba Sanctuary has probably one of the significant populations of the Tragopan in its range. Inner Shorang Valley (Rupi to Dumti [ER=0.08], and Dumti to Muglang Aag Thatch [ER=0.50] and Deiya Thatch [ER=1.20]), Yurang Dhar base [ER=1.67], and interior Lankapuri Valley [ER=1.00] are some of the strongholds of Western Tragopan in the sanctuary. Reports of its occurrence in lower Bhaba Valley and Listegarang Valley (coniferous forests of mountains that overlook Bus-Nagin Nalla) need to be corroborated though historical records exist. Extremely sensitive to human presence and habitat disturbance, though poaching was apparently never a major issue.

Habitat degradation brought about by livestock movements, collection of *guchchi* mushroom, and forest fire are the major threats to the populations in the sanctuary.

Koklass Pheasant: Nearly sympatric with the Western Tragopan, Koklass Pheasants are, however, more tolerant towards human presence and habitat disturbance. This is the most widespread pheasant in Rupi Bhaba Sanctuary second only to Himalayan Monal. Some of the prominent sites of its occurrence include Shamo [ER=0.25] and Gaukanda Dhar [ER=1.00] in Rupi Range, Shal Thatch to Yurang Dhar in Shorang catchment [ER=2.50], Lankapuri forests [ER=0.67], lower Bhaba valley [ER=0.40], and forests along Listegarang drainage [ER=1.00].

Kaleej Pheasant: Essentially a pheasant of the foothills of outer Himalayas, Kaleej occurs in the hill-forests along the main Sutlej Valley and mountains along the downstream valleys of Shorang, Salaring, and lower Wanger Gad (Bhaba). But the true population status of Kaleej Pheasant in the sanctuary is not clear since the species is not easily detected in field-surveys.

Cheer Pheasant: An endemic and globally vulnerable species, Cheer is probably the most endangered pheasant in the sanctuary. Restricted to grass-and-scrub covered hill-slopes and ridges with early successional vegetation, it now occurs in severely fragmented populations. Most parts of its original habitat that existed along the ridges of the main Sutlej Valley and downstream valleys of its tributaries (in the buffer zone of the sanctuary) have been converted into crop-fields and fallow lands. In fact, Black Francolin populations are now fast replacing the Cheer Pheasants in these tracts. The only encounters of Cheer in our survey were in the remnant scrub vegetations along the Sutlej Ridge from Chota Kamba to Salaring [ER=0.40], and the grassy ridges between Salaring Village and lower Phupal Gad valley [ER=1.11]. It is also reported to occur in Nathpa and Kandhar Beats, and this needs to be corroborated.

Himalayan Monal: Arguably the most abundant and widespread species of pheasants in Rupi Bhaba Sanctuary, Himalayan Monal occurs from 2500 m (Zembang near Kimpo-Kyala Dhar in Lankapuri Valley) up to tree line (3500 m at Deya Glacier, Upper Bhaba Valley). The highest density of monals was recorded from the trail from Shal Thatch to Yurang Dhar [ER=8.33], Dumti-Muglang Aag Thatch stretch along Kumrang Gad in upper Shorang Valley [ER=8.00], and around Shamno Dhar in Rupi Valley [ER=5.00]. Heavily hunted for the crest feathers and meat till the recent past, their populations seem to have recovered well from most parts of the sanctuary, barring Bhaba Valley where they continue to be scarce.

Though we did not attempt population census of raptors in the sanctuary, we did note down all the significant observations. In general, the raptor population is

quite significant especially in the buffer zone and alpine areas owing to the more open nature of these landscapes. Among vultures, both Himalayan Griffon and Lammergeier are very widespread and common throughout the sanctuary. In particular, the griffons were observed in good numbers in Salaring Valley and around Katgaon in lower Bhaba Valley. In a stretch of c. 3 km from Khasyan to Pandoshwar base in Listegarang Valley, we counted more than 40 Himalayan Griffons including several juveniles and a couple of old nest/roost sites. Lammergeier was also seen commonly in Yurang Dhar, Gaukanda Dhar, Upper Bhaba Valley, and Listegarang where several juveniles were also sighted. Among the Aquila eagles, Golden and Booted Eagles were seen occasionally in and around Rupi Valley (Shamo Dhar, Gaukanda Dhar, and Tae Dhar) and Shorang Valley (Yurang Dhar – Shujung thatch). Another interesting observation relates to our sighting of a pair of Large-eared Kite near Yurang Dhar (3800 m), where they might breed. The raptors of Upper Bhaba Valley mainly include Eurasian Sparrowhawk and Himalayan Buzzard besides Lammergeier. Among the falcons, Common Kestrel and Eurasian Hobby were seen widely through the sanctuary. Though we did not encounter any Peregrine Falcon in our survey, ideal habitats exist esp. in Yurang Dhar and Salaring Ridges and the peregrines are quite likely to occur in the sanctuary.

4.2.1 Management Prescriptions

- Population monitoring of major pheasants should be undertaken in select ridges and trails by means of call-counts conducted from vantage points, which are marked permanently for the purpose. These early-morning call-counts may be taken up every summer during May-June, when the birds are most vocal. For species like Kaleej, records of their encounters on trails while the team is on mammal survey can be documented. Similarly, raptors should also figure in high priority list for population monitoring in the sanctuary. Specifically, vultures like Himalayan Griffon and Lammergeier should be targeted with documentation and regular watching of their nesting and roost sites.
- Since Western Tragopan is the flagship species for wildlife conservation in the Sanctuary around which all future eco-tourism activities would be centred, it is extremely important to keep a constant vigil on local populations of the tragopans. All the sub- populations in the Sanctuary and surrounding forests (e.g., Rampur forests of Pandrabis section on the west) should first be identified and documented. Efforts should be made to keep all the tragopan habitats (at least in the core area) free from anthropogenic activities like collection of mushroom and medicinal plants and pitching of livestock camps (thatches). Restocking of wild

populations with captive-bred individuals can be attempted in places where suitable habitats exist but with suboptimal populations (e.g. around Shamno Dhar in Rupi Valley). The captive-breeding facility at Sarahan Pheasantry has successfully bred a few Western Tragopans which can be introduced in the Sanctuary as a pilot project.

- Population of Cheer Pheasants in the main Sutlej Valley needs to be studied to understand the degree of fragmentation, and any further modification of their original habitats should be put an end to. If possible, sites where they were reported in the recent past may be reclaimed to their original status, and restocking with captive-bred populations can be seriously considered.
- Poaching of Himalayan Monal, though it is not so rampant as in the past, is still being reported sporadically esp. from Bhaba Valley. This should be controlled and measures to remove disturbances from their habitats should be taken up on a priority basis.
- Informant networks and surveillance strategy needs to be developed, supported by a 'Wildlife Protection Task Force' drawn from forest staff and local people, for undertaking anti-poaching activities.

4.3 Rare and Economically Important Plants

The wild flora of Rupi Bhaba Sanctuary contain several economically important plant species being exploited by the local communities largely for their medicinal properties and as fodder for livestock. A majority of these medicinal and aromatic plants occur in alpine meadows and pastures above the tree line in the sanctuary; among them jungli jeera (*Carum corvi*), bankakri (*Podophyllum hexandrum*), tallish patra (*Rhododendron anthopogon*), karu (*Picrorhiza kurrooa*), dhoop (*Jurinea macrocephala*), hath-panja (*Dactylorhiza hatagirea*), chukhli (*Rheum australe*), patish (*Aconitum heterophyllum*), *Saussurea obvallata*, and gandrayan (*Angelica glauca*) are the most sought-after plants by the locals. In particular, dhoop is also being exported in large quantities; it has been estimated that nearly 2000 quintals of dhoop were exported in five years between 1985 and 1990.

In addition, temperate broadleaved trees like oaks (*Quercus* spp.), Himalayan horse chestnut (*Aesculus indica*), and *Celtis australis* are extensively lopped for their leaves which are used as fodder for livestock. The needles of conifers like spruce and silver fir are particularly used as bedding for cattle during winter. Besides, several species of conifers (esp. deodar) are used as fuel wood.

Owing to overexploitation and habitat degradation from livestock grazing, several of these economically important plants have now become rare in the sanctuary and some of them have even been designated as 'globally threatened' by IUCN Red Data Plants Book. Some of the rarest plants of Rupi Bhaba Sanctuary include *Acer caesium*, *Saussurea costus*, *Erysimum thomsonii*, *Carex munroi*, *Aconitum falconeri*, and *Eremurus himalaicus*. Among these, *Carex munroi* and *Aconitum falconeri* are endemic to the Kinnaur region. According to IUCN Red Data Book of Plants (Nayar & Sastry, 1988), *Saussurea costus* is classified as endangered and *Acer caesium* and *Aconitum falconeri* are evaluated as vulnerable.

4.3.1 Management Prescriptions

- Overexploitation of commercially valuable medicinal plants is a major threat not just to the wildlife habitats but to the population of the exploited species as well. Presently, there is no system of self-regulation among the local communities with respect to collection of medicinal plants. A foolproof win-win model that would suit local conditions, for sustainable extraction of these economically important plants should be developed with the aid of professional organizations like FRLHT. Patches of alpine meadows that are known to house significant populations of rare, endemic, and threatened plants may be fenced off with imposition of 3-5 year cycle moratorium to allow population to recuperate. During this period, other patches can be opened up for regulated extraction and these can be alternated as per the cycles.
- Though lopping of temperate broadleaved trees especially oaks for fodder cannot be stopped altogether, the practice can be weaned off slowly by introducing alternatives like stall-feeding and cultivation of fodder crops in current fallows. This would require a clear long-term plan that should also take the local communities into confidence. If implementing this plan is beyond the scope of the sanctuary authorities, the management should at least make sure that no trees in the core area are lopped or cut down.
- A comprehensive vegetation survey should be undertaken to identify 'local hotspots' of rare, endemic, and threatened plants in the sanctuary. Organizations like Botanical Survey of India and Forest Survey of India can be approached for this purpose.

4.4 Wildlife Health and Diseases

Epidemic diseases are one of the major agents of mortality in wild animals and an outbreak often leads to disappearance of populations and even local extinction of species. Health and disease monitoring, though an integral part of wildlife management, unfortunately does not receive priority in many of the Indian PAs, and Rupi Bhaba Sanctuary is no exception. No initiative seems to have been taken in the past in the Sanctuary to undertake any surveys to assess the health of large mammals like carnivores and ungulates. Presence of a large number of livestock and domestic dogs of shepherd camps in the Sanctuary poses a grave constant threat of disease transmission to their wild counterparts. For example, epidemic diseases like foot-and-mouth disease, rinderpest, anthrax, and haemorrhagic septicaemia are passed on to wild ungulates from domestic livestock. Similarly, domestic dogs are often the reservoirs of canine distemper virus that contracts wild carnivores like felids and canids. Besides these epidemics, there are also localized ailments from which wildlife populations commonly suffer; these include rabies, brucellosis, tuberculosis, ectoparasites, and fungal infections (Sinha, 1975).

4.4.1 Management Prescriptions

- A protocol for monitoring of wildlife health and diseases in the Sanctuary should be developed and implemented forthwith. We strongly recommend for appointment and constitution of a small team of paramedical force under the leadership of a qualified and trained veterinarian at Sarahan Wildlife Division. In this regard, this team should also work in tandem with the local veterinarians of the Dept of Animal Husbandry.
- Regular blood serological surveys should be conducted among the domestic livestock and shepherd dogs to detect any symptoms of epidemic pathogens that pose dangers of transmission to wild animals. Wherever possible, the Forest Department should co-ordinate with the Department of Animal Husbandry in conducting mass immunization programmes for domestic livestock.
- Any cases of natural or unnatural death of wild animals should be attended to immediately and proper post-mortem should be conducted by a qualified veterinarian. These information should be filed in the prescribed format and deposited with the Range Office. In case of mortality detected due to an epidemic, a red alert should be sounded off to higher authorities for further follow-up action.
- The sanctuary management should be provided with all the basic equipments and medicines (including nets, cages, guns, sedatives, tranquilizers, and antibiotics) for treating or isolating disease-affected and wounded wild animals.

Chapter 5. Forest - People Interface

5.1 Villages and People

There are 28 villages in Rupi Bhaba Sanctuary, all lying within the buffer zone mainly along the Sutlej Valley (16 villages) and along the downstream Wanger Gad in Bhaba Valley (12 villages). There are about 1500 households with a population of 6486 people as per 2001 census. The average sex-ratio of the population is marginally skewed in favour of males with 989 females for every 1000 males. However, there is wide variation in sex-ratio among the villages; for example, in villages like Kangrang, Surcho, and Nathpa, the sex-ratio is considerably biased against females, but females exceed males in numbers in Homte, Rokcharang, Chota Kamba, and Dabling. Interestingly, this gender disparity is observed to be independent of social profile of the villages. See Table 11 for population details of the villages in the buffer zone of the sanctuary.

Local communities are largely composed of Rajputs, dalits, and tribals; though large villages like Chota Kamba, Nathpa, Katgaon, and Yangpa have mixed communities, several others are exclusive settlements with either Rajputs alone or with only a mixture of dalits and tribals.

Table 11. Villages in the buffer zone of the Rupi Bhaba Wildlife Sanctuary along with the number of households, population, and social profile according to 2001 census.

S. No.	Village	No. of Households	Total Pop	Males	Females	Social profile
	Range: KATGAON					
1	Kangrang	10	45	26	19	Dalits/Tribals
2	Dutrang					Rajputs and Dalits/Tribals
3	Shango	94	395	193	202	Rajputs and Dalits/Tribals
4	Bai	24	115	52	63	Rajputs
5	Katgaon	165	694	379	315	Rajputs and Dalits/Tribals
6	Surcho	13	52	30	22	Rajputs
7	Kraba	42	231	109	122	Rajputs
8	Yangpa-I	180	876	449	427	Rajputs and Dalits/Tribals
9	Yangpa-II	71	346	178	168	Dalits/Tribals
10	Huri					Rajputs
11	Kafnu	154	705	350	355	Rajputs and Dalits/Tribals
12	Homte	26	135	61	74	Rajputs and Dalits/Tribals

S. No.	Village	No. of Households	Total Pop	Males	Females	Social profile
	Range: RUPI					
13	Kandhar	57	249	125	124	Rajputs and Dalits/Tribals
14	Nathpa	169	589	385	204	Rajputs and Dalits/Tribals
15	Salaring	6	20	12	8	Dalits/Tribals
16	Kachrang	29	128	65	63	
17	Rokcharang	11	52	22	30	Rajputs and Dalits/Tribals
18	Gharsu	37	155	74	81	
19	Chota Kamba	90	351	162	189	Rajputs and Dalits/Tribals
20	Shorang	13	48	24	24	
21	Bara Kamba	87	394	196	198	Rajputs and Dalits/Tribals
22	Dabling	13	75	35	40	Dalits/Tribals
23	Shagarcha	45	165	84	81	
24	Huruva	29	115	58	57	Dalits/Tribals
25-28	[Majgaon Naling-I Naling-II Gurguri]	131	551	266	285	Rajputs and Dalits/Tribals

The local communities are by and large agrarian (with a total cultivated area of 807 ha) and a few young generation members are currently working outside either in government services or unorganized labour sector. Though wheat, rice, and potato are the staple crops for cultivation, people have started to grow apple, walnut, pear, and other commercially viable crops. Animal husbandry (esp. rearing of sheep and goats) has been practiced by the local communities as a source of supplementary income. Besides, collection of non-timber forest products like medicinal plants, wild fruits, fodder, fuel wood, and guchchi mushroom has been a traditional practice among the locals.

A majority of the villages are provided with basic amenities like primary school, angan bari, primary health centre, and mahila mandal bhavan. Facilities like post office, veterinary dispensary, high school, and public distribution shops are available only in large villages. Road connectivity in villages of Rupi Range is almost non-existent, while villages in Bhaba Valley are well connected with the NH-22 by pucca roads. Refer to Appendix 4 for details of village-wise public amenities and infrastructure.

We carried out, as part of the management plan, a demographic and socio-economic survey of the villages in the buffer zone of the sanctuary during May-June,

2008. The survey and assessment was done in two phases: Phase-I covered the villages of Sutlej Valley (Rupi Range) and Phase-II was conducted in villages of Bhaba Valley. While the methodology for the Phase-I was mainly opportunistic observations and secondary information, Phase-II in Bhaba Valley involved intensive field work comprising open-ended household interviews and interactions with all the stakeholders. As such, the following sections on socio-economic and natural resource-use analysis are dealt with separately for the villages of Rupi Range and Bhaba Valley.

5.2 Economic Condition and Access to Amenities

The villages of the main Sutlej Valley in Rupi Range continue to suffer from severe shortage of public amenities including road connectivity and network, with electricity the only amenity the villages have access to. To reach Rupi, one has to cross the deep and narrow Sutlej Gorge from Chura on foot and then undertake a steep 1100 m climb to Rupi Valley, a distance of about 15 km. However, efforts are now underway to connect Rupi Valley with Chota Kamba and Nathpa. The main occupation of the villagers here is cultivation of wheat, rice, and some vegetables like potato. They are also heavily dependent on forests of the core area in the Sanctuary for commercially valuable products like medicinal plants, guchchi mushroom, fuel wood, and fodder. Animal husbandry is a major economic activity with nearly all the households owning livestock. They are gathered in summer and taken to alpine grazing pastures of Rupi Valley and interior valleys of Shorang and Salaring catchments. In general, households of most of the villages (particularly in Rupi Valley) live in abject poverty, while the people of Bara Kamba and Chota Kamba are economically better off.

On the other hand, the socio-economic status of villages in Bhaba Valley is markedly enhanced with much higher per capita income than villages of Rupi Valley. The lucrative apple plantations and employment opportunities in hydel projects have probably contributed to this state of affairs. However, there seems to be perceptible economic disparities within villages and the following factors appeared to influence the economic status of households in general: land holding, acreage under apple plantations, social status and education, access to roads, and possession of livestock and other supplemental sources of income.

Presently most hill slopes in the proximity of villages in the Bhaba valley are under apple cultivation. Apples are a major cash crop and have become the mainstay of the region's economy. Cereals such as wheat and millets which were important crops formerly, have now diminished in importance. Though some minor crops such

as *rajma*, potato and other vegetable also continue to be produced, apples constitute the only significant crop that is exported out of the region. Previously animal husbandry (sheep and goats) was the major livelihood in the region, and a large number of animals were herded to Spiti (a 1-2 day walk from the Bhaba valley over a pass) in the summer and in the Himalayan Foothills and Shivalik-Terai landscape in Himachal Pradesh and Uttar Pradesh (Urttarakhand) during the winter. With the emergence of large scale apple cultivation, animal husbandry has diminished in importance and most households have reduced their livestock holding, and some have altogether stopped rearing sheep and goats. There are two other reasons for the decline in the importance of animal husbandry. Herders report that for the last decade they have faced increasing problems in grazing their animals in the Himalayan foothills in the winter, with the imposition of a ban on their entry into Uttarakhand and other areas. The second reason is that the younger generation, being more educated, aspires for professional or government jobs, or is involved in the profitable venture of apple farming.

The economic status of lower caste villages was not as good as that of upper caste villages. In villages that comprised on both upper and lower caste households, lower caste households tended to be poorer, though we noted exceptions in this pattern. Several lower caste families, particularly in Kangrang, Dutrang and Yangpa II villages own very little arable land and produce few apples. Livestock may be the single largest source of income in such homes, but many families appear to be below poverty line, several families in Kangrang are wretchedly poor.

In many homes at least one male member has a government job, often the Himachal Pradesh Power Department as there are several hydro electric projects in the region and on the nearby Sutlej river. The wealthiest apple farmers in the region have an annual income in excess of 10 lacs. A large number of households, particularly in the upper caste homes have an income between 80,000 and 2 lacs per annum. The poorest homes probably have an annual income in the 5000-10000 range. The villages of Yangpa I, Huree, Kat Gaon and Kafnu have large proportions of affluent families. Most homes have televisions and gas stoves, and several families even own cars or other motor vehicles.

Electricity and water supply systems are adequate, virtually all houses in the region have access to electricity, many homes have piped water. Other infrastructure such as a basic hospital, bank, veterinary hospital and high school exist in the region. Most villages have at least a primary school while a secondary school is located in Katgaon. Schemes to build roads to most villages have received Government clearance and all villages in the region are likely to have road connectivity in the next

5 years. The Bhaba valley is well connected by road, with buses plying regularly to Rekong Peo, Rampur, Shimla and Chandigarh.

5.2.1 Management Prescriptions

- It is known that economic development of communities living close to Protected Areas would considerably reduce their dependency on forests for livelihood. This is also the principle behind various eco-development projects currently being implemented successfully in various PAs of the country including the Great Himalayan National Park in the neighbourhood. In this regard, the stark contrast between Bhaba Valley and Rupi Valley in economic parameters and the corresponding difference in degree by which they rely on forestry resources is interesting and illuminating too. Therefore we reiterate here a key recommendation already made in the previous Management Plan (Pandey, 1991) for a comprehensive, ecologically sound, and economically sensible ecodevelopment scheme tailored to the needs of these mountain communities. All the stakeholders of the landscape including the Forest Department, other locally active government agencies like departments of electricity, animal husbandry, revenue, and rural development, village panchayats, local institutions, and hydel projects should be made representations in ecodevelopment committees and decision-making process.
- To make communication better for the villages of Rupi Valley, maintenance of bridle-paths, foot-bridges across streams, and jhullas (mechanized aerial ropeways) across Sutlej should be a priority agenda for the sanctuary management. In particular, the following jhullas should be taken up for repair and maintenance without any delay: Chaura-Rupi, Tiranda-Chota Kamba, Kachrang-Bhaba Nagar, and Nathpa-Kandhar (all across Sutlej River), and Katgaon-Kraba and Kafnoo-Yangpa (across Wanger Gad). Similarly, the jeepable suspension bridge at Chaura on Sutlej must be taken over from Nichar Forest Division and repaired at the earliest so that the villagers of Rupi Valley are benefited. These bridgeworks often earn immense goodwill of the local people for the sanctuary management; for example, the iron bridge across Salaring River near the village and wooden bridges across Wanger Gad near Homte are much appreciated locally.
- The local villagers should be given priority for recruitments in labour-intensive works of the sanctuary, and imported labour should never be encouraged except for technical expertise. Some of the employment opportunities created by sanctuary management include wildlife survey works, monitoring of forest fire and

other forestry activities, plantation and nurseries, civil works inside the sanctuary, and maintenance of roads, paths, trails, bridges, and jhullas.

- The hydro-electric projects along the Sutlej Valley and downstream of its tributaries should be asked to recruit local people for their labour requirements (instead of the current practice of importing labour), so that the villagers benefit economically.

5.3 Natural Resources Use and Impacts

The pattern and intensity with which natural resources are used locally have wide ramifications for the sanctuary management and these aspects should be taken into account before any management decision is taken. An overriding principle would be the sustainable use of resources, and not a total ban.

Land: Cultivation of wheat, rice, and potato is the major land use of villages in Rupi Valley. Since these traditional crops require a flat and stable field that would involve a significant degree of labour given the undulating nature of terrain, rate of expansion of area under cultivation is much less (cf: apple orchards in Bhaba Valley). But conversion of early successional habitats in hill-slopes into agriculture in Sutlej Valley has affected the Cheer Pheasant populations drastically. This has opened up the erstwhile Cheer habitats to colonization by Black Francolins.

In Bhaba Valley, apple farming has emerged as a profitable industry and has played an important role in the economic upliftment recently witnessed in the region. Most agricultural land around villages has already been brought under apple cultivation. Unlike Rupi Valley, there is a constant encroachment of forest lands where trees are felled and vegetation is cleared to make more land available for apple cultivation. In general, there is an upward movement with forest boundaries constantly being pushed to higher slopes as apple orchards progressively occupy upper slopes. Interviewed people from most villages admitted that encroachment *'nautod'* was widely prevalent. The rampant and unregulated conversion of forest land to agricultural land merits serious action and highlights the need for a clear and well implemented state policy.

Timber & Fuel wood: There is a tremendous pressure on timber, particular for sleepers or beams, which find use in house building. Traditionally, the walls of houses built in this region consisted of alternating layers of stone and interlocking wooden

beams. Further, floors and ceilings were made of wood, and many homes had wooden slats on the roof instead of slate tiles. Although several modifications have occurred, this traditional design remains popular owing to the excellent insulation it offers against cold weather in winter. While the dependence on sleepers and beams for house-building has reduced slightly on account of the availability of other construction materials, a growing population in the region and a preference for wood over cement concrete has resulted in sustained demand for large quantities of timber. Preferred species include deodar, fir and pine. Newer houses built out of modern materials such as bricks and cement utilize large quantities of wood for windows, doors, frames, floors and ceilings. In the more affluent of the surveyed villages in Bhaba Valley, many families own more than one house. Constructing a second or third house is often possible primarily because materials such as wood are available at relatively low cost. Most interviewed people admitted that with unrestricted felling, forests in the region had diminished to a great extent over the past three decades, and that they were no longer as dense as they used to be. The more valued trees such as *Abies* (fir) and deodar were now unavailable in many areas, and trees with large girth classes were not encountered in the proximity of villages. Regeneration in most forests in the proximity of villages is reportedly very poor with saplings being destroyed by herbivores (livestock), fires and wanton felling.

To acquire wood for house-building, villagers simply help themselves to trees from adjacent forests at will. The Timber Distribution (TD) system that permitted villagers to "officially" fell green trees for legitimate needs was discontinued a few years ago. Many people opine that the TD system, though necessary, was poorly implemented; people who were sanctioned one or two trees would frequently fell many more than they were authorised to. Currently there is a complete ban on the felling of green trees. Notwithstanding this, there is ample evidence of unregulated and unauthorised tree felling; newly cut sleepers and logs were deposited in almost every village we visited. Several new houses being constructed had used large quantities of freshly cut beams. On foot trails around villages, we frequently encountered large patches with many neatly-sawed tree stumps. Between Dutrang and Kangrang, the base of every pine tree in a patch had systematically been burnt; many trees had been felled (stumps were seen), and freshly cut sleepers lay in a stack below the path. In Surcho, an apple cultivator had felled a 12 foot regenerating *Abies* tree as support for his cucumber plant in front of his home.

Although the felling of green trees is rampant, it appears that a section of people regularly fell and sell timber in the Bhaba valley. In all the villages we visited, it was alleged that there was a large scale smuggling of timber, especially poles, from

the Mulling area into the wood-deficient Spiti region. Some interviewed villagers even claimed that wood was being smuggled out of the region and being sold at high prices in urban centres in Himachal and elsewhere.

Most households in the region use both fuel wood and cooking gas. In the winter months, however, large amounts of wood are burnt for heating. Villagers claim that much of this wood is collected from dead trees in the sanctuary (those that have been destroyed by landslides or avalanches). There was also evidence of some green timber being used in this process. A considerable portion of fuel wood is also extracted from the pruning of apricot and other fruit trees that grow in orchards or along village margins.

Livestock grazing: Villagers in Rupi Valley take their livestock for grazing to high-altitude alpine meadows every summer. In particular, pastures of Shamno Dhar, Deiya pasture in upper Shorang Valley, Yurang Dhar, Lankapuri, and Phupal Gad pastures are preferred. *Thatches*, which are semi-permanent cattle camps in pasturelands where single-crop farming is also undertaken are quite common in the interior valleys. At present, there seems to be no mechanism (either internal or external) to regulate the livestock camps and control their numbers. This has resulted in overgrazing and many of the fertile alpine meadows have now become infested with unpalatable species like *Rumex* spp. and *Anemone* spp.

In Bhaba Valley, a large number of livestock enter the sanctuary each area in the summer and monsoon months. A large number of these are from the 13 villages of the Bhaba valley itself, but a considerable number are also from other regions. It appears that permits are issued for livestock to be grazed in the area by the Forest Department but we were not able to verify whether most animals being grazed in the sanctuary had permits. The livestock from the Bhaba valley villages are primarily grazed in the Mulling alpine pastures en-route to Spiti, while other alpine pastures are used by herders from regions other than the Bhaba valley. A considerable proportion of the livestock from the Bhaba valley are herded over the pass into the neighbouring Spiti-Kaza region for the summer months, as forage in Spiti is believed to be of superior quality. Because livestock from this region are grazed in Spiti, people do not challenge the reported extraction of timber from the Mulling forests by the residents of Spiti.

Fodder is extracted both from within the sanctuary and from the apple orchards (because the land beneath apple trees is fallow and yields considerable amounts of palatable grasses and herbs). With no major broadleaf forests in the

Bhaba valley, the lopping of trees for fodder is not prevalent around villages although people reported that some fodder yielding tree species close to the tree-line were lopped in the autumn to provide winter forage.

NTFP collection: The main non-timber forest products include medicinal plants, guchchi mushroom, and other minor products like honey and animal by-products. A majority of these medicinal and aromatic plants occur in alpine meadows and pastures above the tree line in the sanctuary; among them jungli jeera (*Carum corvi*), bankakri (*Podophyllum hexandrum*), tallish patra (*Rhododendron anthopogon*), karu (*Picrorhiza kurrooa*), dhoop (*Jurinea macrocephala*), hath-panja (*Dactylorhiza hatagirea*), chukhli (*Rheum australe*), patish (*Aconitum heterophyllum*), and *Saussurea obvallata*, are the most sought-after plants by the locals. In particular, dhoop is also being exported in large quantities. The *guchchi* mushroom which emerges in damp moist forest floor during monsoon is reportedly delicious and a highly priced product that may fetch Rs. 8,000 -10,000 per kg in retail markets. In particular, dense forests in deep interior valleys of Lankapuri and Phupal Gad Valleys are the major source for guchchi mushroom, and hundreds of people throng these areas every monsoon in search of the mushroom.

5.3.1 Management Prescriptions

- A comprehensive and ecologically compatible land use policy should be developed for the buffer zone of the sanctuary; the plan should fetch additional income to the people with less damage to the wildlife habitats. In Bhaba Valley, encroachment of forest land by expanding apple orchards should be put an end to. Similarly, conversion of Cheer Pheasant habitats to crop-fields along Sutlej Valley should be curtailed.
- The traditional rights of people ensuring access to timber for bona fide building purposes (TD system) should be revived so that illegal cutting of wood is minimized. But at the same time, the new TD system should be made more transparent and free of corruption and nepotism. Plantation of deodar and pine may be raised near villages for their exclusive use and villagers may be asked to manage these plantations. In any case, smuggling of timber should not be allowed to outside the sanctuary (like Spiti Valley), and no felling of trees or any woody vegetation be tolerated inside the core area.
- Regulation of livestock camps should be made more professional as per the recommendations given elsewhere in the Management Plan. More vulnerable parts

of alpine meadows and pastures may be fenced off temporarily to encourage growth of palatable species of herbs and grasses. Similarly, collection of medicinal plants and *guchchi* mushroom should also be regulated through an internally evolved mechanism among the local communities so as to ensure sustainable harvest of these precious resources.

- We observed quite a few small patches of tilled lands planted with potato by the local shepherds well inside the sanctuary limits in Listegarang valley. It needs to be curbed forthwith, as any expansion of these cultivated lands in near future would spell disaster for the sensitive wildlife habitats and it may be too late to act.

5.4 Development Imperatives

With the recent rise of market-economy and subsequent emphasis in government policy on growth of infrastructure and grassroots development, it is natural that villages in the buffer zone of Rupi Bhaba Sanctuary are also going through this momentum of change and development. The ramifications of these developmental forces on the integrity of wildlife habitats and populations in the core zone of the sanctuary are still to be seen. However, the sanctuary authorities should anticipate any eventualities that would arise out of these developments and should have a sound contingency plan to overcome future challenges. For example, the hydel projects have opened up the Bhaba Valley to outside world, and wildlife and adventure tourism is a recent offshoot of this development. But the sanctuary management did not have a clear policy on ecotourism, and most of the decisions were taken *ad hoc* at the level of Forest Range Office often with contradictory implications. Similarly, there are several plans afoot to bring these parts of Kinnaur into mainstream economy through initiatives like establishment of fruit-processing centres and apicultural farms. Though these development imperatives are essential to the local economy and, in a sense, may eventually prove to be beneficial to the sanctuary by reducing the degree of forest dependency of local communities, they also run the risk of widening the gap between economically rich and poor sections of the society. In that case, this would spell disaster for the sanctuary, as poverty would begin to have telling impacts on forest resources.

5.4.1 Management Prescriptions

- The sanctuary authorities should not be unduly rigid in their approach towards issues that would affect the local economy, and instead, should show principles of adaptive management. Prudent and innovative solutions should be sought in

conformity with the laws of the land so that all the stakeholders stand to gain. However, in case of conflicts, welfare of rare, endemic, and threatened wildlife should be the paramount concern and no leniency should be shown in this respect at any cost.

- The sanctuary management should ensure that benefits of economic development are more equitably shared among all sections of the society and local institutions like van panchayats, proposed under this Plan, can be the medium of implementation.

5.5 Local Institutions and Support Groups

In Rupi Valley, there are no local level institutions to deal with the issues of natural resource use. The only organized human resource forum that has found representation in every village is the women's self-help groups (Mahila mandals).

Of the 13 villages in the Bhaba valley, only two have committees that address issues related to natural resource management. The village of Bai, has for several years, devised and implemented a forest-protection plan for a deodar forest in the proximity of the village. With a reduction in the availability of deodar in the region, Bayei's deodar forests were reportedly under severe pressure for timber. The village community evolved a plan to protect the forest, and with the assistance of the forest department, they erected a fence around the deodar patch, and planted new trees within it. The village community then ensured that no grazing animals were allowed to enter the patch; if someone faulted this rule, he was fined. Few or no trees were cut from within this forest patch. The only significant surviving deodar forest near Bai stands as testimony to local efforts in forest conservation. In Katgaon, there is a newly formed forest committee that intends to take up plantation activities and encourage the community to protect forests. A fenced patch of regenerating deodar on the true right bank of the river above Katgaon was planted by villagers about two decades ago. Villagers assert that because they planted these trees from their own initiative, they have zealously protected them over the years. This patch is surrounded by apple orchards, many of which are likely to be encroachments in the sanctuary land.

Although a large number of plantations have been undertaken by the forest department over the years, villagers claim that such activities have inadvertently resulted in failure for a number of reasons:

- Improper site selection; dry, rocky and arid areas unsuitable for trees such as deodar are sometimes selected for plantations.

- Inadequate fencing.
- Even when fending is present, inadequate protection against livestock.
- Fires (usually started by herders to promote the growth of new grass).

Ultimately, such plantations are however doomed to fail because of a lack of co-operation by locals in such initiatives. They say that they do not cooperate with the department in plantations because:

- They are seldom consulted about the plantations (site selection, species etc).
- Instead of involving villagers in plantation activities, the Forest Department usually awards a contract to one or two villagers who hire *gorkha* labourers to plant trees. This has caused a lot of resentment among the villagers, particularly the poor and unemployed who wish to be hired as labour for forest department activities.
- Allegations of gross financial irregularities and a lack of transparency in plantation activities; far fewer trees are planted than shown on paper.
- Improper planting; pits are shallow, often several saplings are placed in the same pit, little or no post-planting care is provided.
- Owing to a lack of involvement and a loss of faith in the Forest Department's modus of tree-plantation, some locals develop a vindictive attitude and deliberately graze their livestock within plantation areas or let them be destroyed by fires.

Government fallacies alone cannot however be blamed for the destruction of forests in the Bhaba valley. In many villages, there is clearly an unfortunate loss in a sense of responsibility and foresight in relation to forest management. There are no rules, tree felling is not reported to the Forest Department and in most villages nobody has taken on the responsibility of planting new trees to replace felled ones. All interviewed people were unanimous in saying that they would support the creation of a "Forest Committee" at the village level to devise ways of protecting their forests. Most people also demanded that the TD system be re-introduced. However, it appears that the former TD system was severely flawed; the affluent felled as many trees as they wished to and the poor were often denied access even to legitimate or real needs. There was a general opinion that a section of society was exploiting the regions forests in an insensitive manner and that *ad hoc* and rampant deforestation ought to be controlled through better implementation of Forest laws and through the formation of 'forest committees'.

5.5.1 Management Prescriptions

- It is increasingly realized that participation of local communities is a must for protection and sustainable use of natural resources in Protected Areas. Such a participation of local stakeholders is possible only through an institutionalized mechanism which would enable the local communities to devise and evolve their own system of natural resource use. Unfortunately, the villages in the buffer zone of the sanctuary do not have any such village level forum barring a few new initiatives in Bhaba Valley. The sanctuary authorities should immediately convene village level meetings to brief them about the need, modality, and functioning of 'village van panchayats'. These van panchayats should comprise elders of the villages and should represent all communities and other stakeholders as well. Fallow and degraded forest lands can be identified close to villages and each van panchayat should be assisted to raise 'village forests' (mainly of deodar and pine) in these lands. Later, the management rights of these village forests can be transferred to van panchayats. These village level institutions, with the aid of the sanctuary authorities, can also regulate the livestock camps and grazing in alpine areas and collection of medicinal plants.
- Self Help Groups (SHGs) need to be established to take forward ecodevelopment and eco-tourism activities. The people can be encouraged to develop 'Home Stay' facility for visitors and they can also be trained to be 'Nature Guides' for trekkers and wildlife enthusiasts. A Community Centre can be established in appropriate site, where people-people and people-management interactions can take place for better management of the Sanctuary and to resolve any issues that hinder PA management.

5.6 Human-Wildlife Conflicts

Though the instances of human-wildlife conflicts are relatively low in Rupi Bhaba Sanctuary in comparison to other PAs in western Himalaya, an increasing number of people-wildlife confrontations are being reported from different parts of the sanctuary. Discussions with the villagers of Kachurang, Rukcharang, and Salaring elicited a large number of complaints about the growing instances of human-wildlife conflicts in the valley. In particular, cattle lifting by Common Leopard and human attacks by Black Bear seem to be a burning issue in this part of the sanctuary. In fact, on 9th May, 2008, when we were inside Lankapuri Valley on wildlife survey, one leopard attacked a full-grown cow in the heart of the Kachurang village in broad daylight (12.00 noon) and apparently left the scene only after having a sumptuous

meal of it... all in front of a large gathering of onlookers! The problem of encounters with Black Bear seems to be particularly high during winters and monsoons. In the winter of 2007, one 8-year old boy was badly mauled by one bear when he was collecting firewood just outside the village of Rukcharang. The villagers also complain about extensive damage to potato fields by porcupines, both the freshly-sown and harvest-stage crops. Villagers insist on extension of the provision of adequate compensatory package in such cases of human-wildlife conflicts inside the limits of the buffer zone as well.

In Bhaba Valley, monkeys, bears and leopards were reported to be the 'problem animals'. Almost 60% of interviewed households perceived bears as a major menace for causing damage to the apple crop. About 90% of all respondents claimed that their crop was routinely damaged by monkeys. Livestock owners and shepherds complained that their animals were routinely preyed on by Common Leopards, Snow Leopards, and more occasionally by Brown Bears, in alpine pastures during summer. Common Leopards occasionally attacked livestock within villages as well, but no loss of human life was reported.

Himalayan Black Bears frequent the surrounds of the villages of the Bhaba valley, lured by the abundance of fruit and other crops in the fields. Interestingly, villages most affected by bears typically have orchards along the upper fringes of agricultural land; areas that are usually the most distant from homes and most proximate to forests. It is likely that several such patches are encroachments into forest lands. Villages that are lower down in the valley, or surrounded by other villages face less damage from bears. Orchards that are hemmed in by other orchards are also less prone to being raided. Bears usually frequent orchards the most when apples ripen (in autumn). Apart from picking fruit of trees, they often snap twigs and branches, thus causing significant long-term damage. Most apple orchards have rudimentary thorn fences around them, but these may not suffice as deterrents for hungry, raiding bears.

Monkeys were reportedly absent in Bhaba valley until about two decades ago. Now both Rhesus Macaques and Common Langurs, it is said, occupy the region in large numbers and feed on the abundant fruit bearing trees. However, during our survey, we did not record the presence of any monkeys and we suspect that there may be a few large and cohesive groups that move about in the region together.

5.6.1 Management Prescriptions

- The sanctuary management should have clear guidelines for awarding compensation to victims of human-wildlife conflicts. The official procedures involving field-visits to the site of conflicts, on-site evaluation, and paper work need to be streamlined so that compensations are paid well in time. The entire procedure should be transparent and free from corruption. The long-standing demand of locals for extending the compensation scheme to cases that occur inside the sanctuary limits cannot be considered in view of the legal tangles involved. However, instances inside the buffer zone of the sanctuary can be positively considered for compensation on a case-by-case basis. But this should be compatible with the general policy of the State Government.
- Standard precautionary measures against possible bear attacks have been framed by various wildlife organizations like WII. These guidelines should be made public in Hindi and efforts should be taken by the sanctuary authorities to spread this message of awareness through various means.
- Professional organizations can be approached to study the problem of crop damage by porcupines and bears in potato and apple fields and to devise counter-measures to control the problem.
- The recurring problem of human-bear conflict needs to be understood clearly as to whether it is caused by few repeated offenders getting used to the crop fields or it is mediated by lack of food resources in the forest areas. Watch dogs would offer short term help. It would be useful to radiocollar the crop raiding bears and monitor their activities. Holding facility could also be set up in each Ranges, so that problem animals can be rescued and released appropriately. Similar approach is applicable for other species that are involved in conflict with human.

5.7 PA *versus* People: How to Reconcile?

It is very unfortunate that the Forest Department has a very tainted reputation in the Sanctuary. The rampant and uninhibited deforestation in the region points to severe flaws in monitoring and implementation of the Forest Protection Act by field staff of the department. Villagers allege that field staff are either hand-in-glove with people felling trees, or just turn a blind eye to such activities. On the other hand, the sanctuary staff accuse that villagers often defy the laws openly and would not co-operate with the management. To effectively implement conservation and compel people to respect the sanctity of the Sanctuary, the Forest Department needs to urgently take several steps:

- Tree plantation ought to be a priority to replenish fast depleting forests (Appendix 14). However, the Department must realize that for a plantation to be successful, the active participation of local communities is essential. Villagers must therefore be consulted and involved at all stages of plantation. Local people must be provided opportunities to work as labour for sanctuary maintenance works.
- There is a need for greater transparency in forest Department projects to inspire confidence in the department.
- There must be an interface between the Forest Department and local communities through the formation of Forest Committees. The department has a role in educating people about the consequence of forest loss, and about the ecological and economic services and functions of forests in the proximity of villages.
- If new field staff is hired, they need support from their seniors in tackling violations such as tree felling. Village communities are often politically connected or influential, and without the backing of superiors, field staff are constrained and are unable to apprehend or take action against defaulters.
- The department must recognize that local people have legitimate needs for timber, fuel wood and other natural resource and must work towards helping communities meet their basic needs. Local communities are also callous in their extraction of a natural resources because Government dominion over forests for decades has destroyed their sense of ownership and judicious resource management strategies. The Government must ensure that people have a stake in forest management and are thereby inclined to protect it.
- Livestock have traditionally been grazed in alpine pastures and meadows in the sanctuary and grazing is often unregulated. The management needs to establish realistic boundaries for the sanctuary, keeping in mind that local populations will inevitably seek to use resources in their proximity. Unrealistic sanctuary boundaries will either be redundant, or will lead to heightened conflict between the Forest Department and local human populations. For instance, thousands of sheep and goats and a large number of cows are grazed in the Mulling pastures in Bhaba Valley each year. Including this area in the sanctuary without resolving the grazing rights and recognizing legitimate grazing areas will only lead to conflict or make law enforcement impossible. Efforts should be made to offer stall-feeding opportunity for people whose primary occupation is animal husbandry. Fodder species can be planted in the buffer areas and waste lands (including of communities hired on leases), and local demand could be met from these plantations.

- The traditional Timber Distribution rights may be revived with necessary modifications to make the process transparent and impartial.
- There is an urgent need to create forest protection committees in which women and lower caste people also have a voice and are involved in decision making. Forest department involvement in the creation of women-self help groups to promote livelihood options that bring in supplemental income, or ensure fuel wood and fodder security is also welcome.
- There should be a system of incentives to encourage people to plant and protect forests. Such incentives may be financial, or in the forms of awards or recognition being provided to individuals or villages who contribute to conservation.

The Bhaba valley; note the deforested lower slopes. Several of the surveyed villages are visible

Yangpa I, the most affluent village in the Bhaba valley. Note the sparse forests and the extensive apple plantations

Traditional house constructed about 100 years ago. Fuel wood for cooking and heating is stacked near all houses in the region

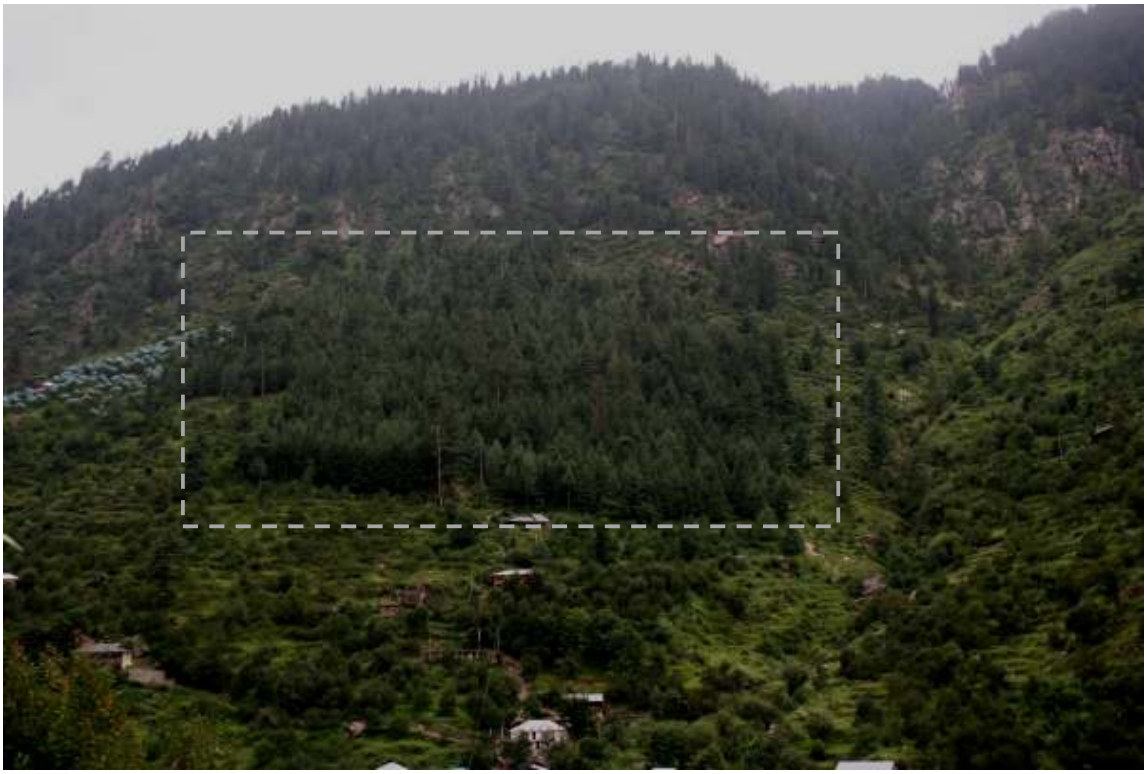
Modern cement-concrete house

Deforestation in a pine patch

Stacks of wood beside path; a common sight in the Bhaba valley

New house being constructed in traditional style

Regenerating deodar forest near Kat Gaon. This forest was planted by the residents of Kat Gaon and has been protected by them. In contrast, most plantations carried out by the forest department alone are unsuccessful.



The Dam at Kafnu. Inhabitants of the Bhaba valley say that the dam led to the economic upliftment of the region's population.

Chapter 6. Management Effectiveness

6.1 Staff Strength and Quality

Rupi Bhaba Sanctuary, being located in the Great Himalaya, is characterized by a steep, precipitous terrain with harsh weather and poor access to deep interior valleys. This makes the working conditions of the field-staff wholly unenviable and one has to be highly motivated to render full justice to their job. The staff strength, qualification, motivation, and incentives should figure high on the agenda of management if plans and programmes are to be delivered on the field.

Number and qualification: There is currently a severe shortage of field-staff in the Sanctuary management, and the organization structure is top-heavy with few frontline staff. This has ostensibly affected the regular operations like anti-poaching camps, fire-control, infrastructure maintenance, and regulation of grazing camps. Though a new batch of about six fresh forest guards had joined the sanctuary management during our field-visit in May 2008, this reinforcement was still inadequate given the requirements of the sanctuary.

The minimum educational qualification for the post of Forest Guard is successful completion of school education (10+2), but quite a few Forest Guards now posted in the Sanctuary possess a university degree and are well-versed in written communication in both Hindi and English. These Forest Guards, prior to their posting, undergo a professional training of one-year period at the State Forest Training School at Solan / Chamba. The senior staff like Forest Range Officer and Assistant Conservator of Forests are trained in national academies like State Forest Service College, Dehradun. However, none of the staff in the Sanctuary has acquired any additional qualification through mid-service training or coursework.

The average age of the field-staff at Rupi Bhaba Sanctuary would be well over 45 (excluding the newly joined Forest Guards on probation). Though most of them were found to be physically fit during our field-survey in 2008, the weariness arising probably out of monotony of the job with little motivation was writ large on them.

6.1.1 Management Prescriptions

- Considering the existence of a number of complex issues in the sanctuary coupled with its harsh terrain and working environment, the current staff strength of the Sanctuary is much below its requirement and we strongly recommend for posting of additional staff with an ideal staff strength as follows:

S. No.	Name of Post	No. of posts, required	Remarks
1.	Forest Range Officer	2	In charge of Range
2.	Deputy Ranger	3	In charge of Block
3.	Forest Guard	24	Two each per Beat
4.	Peon	4	Two at HQ and one each at Range Office
5.	Chowkidar	2	Addition subject to new rest-houses proposed
6.	Dak helper	2	Addition subject to new rest-houses proposed
7.	Driver	4	
8.	Khalasi	3	
9.	Wireless operator	3	Addition subject to new stations proposed
10.	Jhulla operator	8	Two per jhulla
11.	Reserve for contingency	12	Temporary position for anti-poaching, fire-control and other contingent tasks. On-call duty.

- We also like to reiterate here the suggestion of earlier management plan that only persons below the age of 45 years be posted inside the Sanctuary and they should be physically and mentally fit and tough to face the challenges of the mountain PA.
- The staff should be encouraged to enhance their professional qualification by enrolling for regular in-service courses and specialized training from other state and national organizations like Wildlife Institute of India and Forest Survey of India from time to time.

Awareness and motivation: Though the forest staffs in the Sanctuary were, by and large, physically fit and strong, we found that their level of general awareness of the local wildlife and habitats was considerably short of our expectations. Even the new breed of freshly trained Forest Guards, for that matter, was not better off, barring a few. For example, almost all the senior staff who accompanied us in our field-surveys were not able to detect and recognize the telltale signs of Snow Leopard at alpine areas above snowline. Nor they were able to examine the browsing signs of ungulates like Musk Deer and Serow or age- and sex classification of individuals of Himalayan Tahr or identification of small carnivores from pugmarks. Though local guides who usually accompany the staff on their field-visits have deep understanding of the area and exemplary field-craft including knowledge of the signs of major wildlife species, the forest staff seem to be clueless about natural history of the sanctuary barring the identification of medicinal and other economically important plants.

One of the reasons for the generally poor awareness of the staff, despite their long field-exposure and accompaniment of knowledgeable local guides, could be the abysmally low level of motivation that marks nearly the entire staff of the sanctuary. The remoteness of the sanctuary with no basic facilities for health or good primary education means that most of the staff has to put up their families in nearby towns like Rampur, Jeori, or Sarahan. But their job profile demands that they are present and available in the field round the clock throughout the year and they hardly get to spend time with their families. Also, there seem to be no official reward or incentives for the best services though punitive measures for negligence or slip-ups in duty are very much in place.

Another major factor for the low level of motivation among the lower staff is unfortunately a lackadaisical leadership at the headquarters. Though this is likely to be rebutted by the authorities concerned as a misplaced point, it is very much true. For example, the field staff, during our field-visit in May 2008, used to talk very highly of the tenure of some previous DFOs in a rather wistful tone. Clearly, they seemed to have become low in morale on account of the then leadership though they were reluctant to openly say so.

6.1.2 Management Prescriptions

- The frontline staff of the sanctuary should be regularly given hands-on training on the field on different aspects of wildlife management including survey methods for large mammals and pheasants, reading and interpretation of signs and evidences of wildlife, assessment of the state of wildlife habitats, and evaluation of wildlife health. Experts from organizations like Wildlife Institute of India, the state Forest Department, and research NGOs can be approached to impart this exclusive training programmes.
- The sanctuary management has to find some innovative ways to boost the sagging morale of the frontline staff.
- The foremost measure would be the frequent field-visit of the higher authorities from time to time, and they should accompany the lower staff into interior valleys as well.
- There should be sufficient provisions in the management guidelines for recognition of exemplary service and good work carried out by the lower staff. The incentives can include monetary benefits, awards, and out-of-turn service points.
- The higher authorities should frequently hold grievance meeting of the lower staff in which all the genuine issues of the staff should be addressed to immediately.

- The lower staff should be paid extra allowances towards their living costs of high-altitude life in conformity with the pay policy of the Government of Himachal Pradesh. They should also be generously provided with all the necessary paraphernalia for trekking and camping.
- Finally, the sanctuary management should inculcate a sense of purpose and achievement with a goal-based approach in the work ethic of the staff, promoting teamwork and zero-tolerance towards mediocrity.

Interpersonal communications: Communication and rapport between the forest staff and the local people are essential components of PA management and aids in building intelligence that helps authorities to respond to challenges swiftly and efficiently. This flow of information is also necessary for developing an adaptive management strategy for the PA. In that sense, most of the Forest Guards in Rupi Bhaba Sanctuary, being locals, seem to have developed a reliable network of informants and acquaintances among the local public. But this has its own share of problems, as it paves way for emergence of favouritism (esp. in Timber Distribution recommendations) and even corruption (e.g., illegal felling of trees for buildings). In fact, several people in Bhaba Valley have complained about the lack of transparency in all the dealings of the sanctuary management. Though regular periodic transfers are effected within the sanctuary and sometimes within the limits of Sarahan Wildlife Division (which also includes Dharangati Wildlife Sanctuary, Lippa Asrang Sanctuary, and Sangla valley), this does not completely do away with the problem as only officers above the rank of Forest Rangers are usually transferred across divisions in the state.

Communication within the hierarchy of the sanctuary management is a vertical process in which the role of the Forest Range Officer is key to the effective flow of information from both the ends. The management protocol warrants that there should be regular convening of staff meetings within a Range and frequent review meeting of Range Officers called by the DFO. But it is not clear how regular or frequent are these meetings currently being held in the sanctuary. However, we did not notice any major communication gap between the higher authorities and lower staff during our three-month long stay in 2008.

6.1.3 Management Prescriptions

- A good network of intelligence is essential to the sanctuary management, and as such, the frontline staff should be encouraged to liaison with the local people and gather crucial opinions and information.

- There should also be an effective check at the same time to ensure that such liaisoning with the locals does not lead to nepotism or corruption with respect to timber distribution or issuing of license for livestock camps.
- Interdivisional transfer of staff at the level of Forest Guards should be made part of the management and especially movement of frontline staff across neighbouring PAs like Pin Valley National Park and Lippa Asrang Sanctuary should be encouraged.
- Regular interactions of lower staff with the sanctuary authorities should be organized and institutionalized through protocols and minutes of these meetings should be recorded properly and followed up.

Capacity building: A mountain Protected Area like Rupi Bhaba Sanctuary always continues to throw up new challenges and unforeseen developments, and the sanctuary management should be able to evolve appropriate solutions on the basis of prior experience and new approaches. But to enable such adaptive management, the staff should update themselves with the new, emerging tools and concepts being developed by advancing science of wildlife management. As far as we know, no capacity-building initiative seems to have been taken for the lower staff in the sanctuary. As we pointed out earlier, the general awareness of the staff about natural history of the landscape and their field-knowledge are unacceptably low. They are not at all familiar with some of the basic operations of the sanctuary like wildlife population surveys, evaluation of wildlife habitats, assessment of wildlife health, and legal procedures involved in prosecution of wildlife-related crimes.

Besides, the staff also should be provided with the necessary material resources for a life in mountain and alpine areas through all the weathers. Currently, very little camping and trekking equipment have been provisioned to the field staff. Though some basic field-guides and technical manuals are available at the headquarters, frontline staff hardly has access to them.

6.1.4 Management Prescriptions

- Capacity-building workshops and training sessions should be regularly conducted in the field for the lower and middle level staff in various aspects of wildlife management and conservation. Professional organizations like Wildlife Institute of India, Forest Survey of India, and Institute of Himalayan Bioresource Technology (Palampur), can be approached for imparting these trainings.
- The sanctuary management, in general, should now adopt new-age spatial tools and techniques like use of GIS and remote sensing for mapping the sanctuary, resource mapping, distribution of wildlife populations, fire-incidence, etc. A

dedicated GIS lab should be commissioned at the head-quarters along with a team of trained personnel and required tolls and software.

- The frontline staff should be adequately provided with all the necessary paraphernalia for mountain trekking and camping.
- Similarly, a set of basic wildlife field-guides and manuals should be given to each of the staff for their use in the field. These may include identification guides for mammals, birds, and flowering plants of the Himalaya, illustrated companion to wildlife crime, technical manuals for wildlife population surveys and habitat assessments, and guidelines for conducting wildlife health surveys and sampling. The technical publications of the Wildlife Institute of India may be translated to Hindi, with due permission from the authorities, and given to the staff for their use.

6.2 Availability and Distribution of Infrastructure

Though Rupi-Bhaba Sanctuary is home to a great diversity of Himalayan flora and fauna, the current state of affairs at its management is far from satisfactory. In fact, there were hardly any signs of proactive management barring a few committed frontline staff, when we visited the Sanctuary in April-June, 2008. A nearly non-existent infrastructure that is marked with low budgetary support and acute shortage of field staff underlies the PA management of the sanctuary. This is very unfortunate especially when there is a high potential to develop the sanctuary into a model PA where livelihood needs of local communities can be sustainably achieved with emphasis on conservation of native biodiversity through promotion of ecotourism. Ironically, such a successful model is being implemented in the neighbouring GHNP, and this can be replicated in Rupi-Bhaba WLS with modifications.

6.2.1 Management Prescriptions

- We have outlined here some of the most urgent and immediate measures for infrastructure development including communication network and mobility and protection measures in the sanctuary on the basis of our field-visit and survey.

  Rupi Valley:

- The trail between Rupi FRH and Gaukanda Dhar should be upgraded to a proper bridle-path for opening up ecotourism ventures here.

Shorang Valley:

- Dumti is a strategically important point, as nomadic shepherds use Kumrang Ghad trek as traditional route to Bhaba Valley in summer. Therefore, it is imperative that a fully functional forest-chowki be built at Dumti camp-site for better monitoring purpose. The chowki can be modelled as a platform-based structure with roof, raised on four pillars as this would double as watch tower and also provide safety from wild animals. The forest guards and watchers should visit regularly (probably twice a month) and may stay for a couple of days. Regular presence of forest staff would go a long way towards curbing of poaching and other illegal activities. To make access easier to Dumti, a wooden/steel bridge needs to be built across Shorang Ghad upstream.
- Dughe is an ideal site for locating a watchtower from which one can have long view of Shorang Valley below well up to Talpo. Plantation works can be taken up here as the ridge offers some flat terrains. However, access path from Dumti Campsite needs to be repaired, as the old path got eroded away. Some measures to check erosion (like wire-meshed boulder walls) are already in place by the FD along lower ridges. These boulder walls can be replicated in erosion-prone slopes elsewhere as well particularly where paths and treks are aligned alongside.
- The old Forest Chowki/Quarters at Shorang is now abandoned as it was hit by a huge rockfall some years back. This can be renovated with sufficient safety measures against rockfall, with two storeys. While the lower storey can accommodate the Beat Guard office-cum-residence, the upper storey can be used as a transit facility for visiting officials and trekkers. This chowki would also be strategically important to monitor and regulate the movement of shepherds and collectors of NTFPs (mainly the *guchchi* mushroom).
- There should be a Forest Guest House and an interpretation centre for visitors and tourists ideally located at Chota Kamba. The interpretation centre may showcase several themes like biogeography, flora and fauna, soil and water conservation, ecotourism initiatives, livelihood issues of local communities, and sustainable use of forestry resources. This centre can cater to the ecology and environment of the Great Himalayan Range, while a similar one can be set up at Katgaon in Bhaba valley for the high-altitude alpine pastures and glaciers.
- The Yurang Dhar peak offers, literally a bird's-eye-view of the entire sanctuary from Rupi valley in the west to Bhaba Valley in the east. However, the bridle path from Chota Kamba to Yurang Dhar is well-maintained only till Yād-Sāt after which it is in a run-down state. This needs to be taken up on a priority basis, as this

would also make the monitoring and patrolling much easier and this part of the sanctuary houses a good density of Gorals, Himalayan Muskdeer, and Western Tragopans.

- Access to Yurang Dhar after Shal Thatch is very precarious as there is no bridle path. It is important that a new route be built and maintained by the FD. It should be noted here that bridle-paths should not be aligned along rivers/streams, as they are snowbound most part of the year and tend to get eroded away soon. Yurang Dhar is one of the potential sites for trekking tourism and a fairly good wildlife population and habitats exist here; still, no forest dept personnel visits it for want of proper access and other infrastructural amenities.

Salaring Valley:

- There is a small well-constructed steel-iron bridge across Salaring River just before the Salaring village. This was built by the Forest Dept for the benefit of the inhabitants of the small village of Salaring during 2006-07. This gesture has apparently received great admiration and gained enormous goodwill from the local communities. The same model should be replicated in other localities too. This also strengthens Forest Dept infrastructure for easy access and efficient monitoring.
- The trek from Salaring to Lankapuri Valley crosses Lankapuri River at about 50 m before the Chikap Gad joins Lankapuri Gad and one has to wade waist-deep here through freezing cold waters. A wooden or steel semi-pucca bridge has to be built here, as this is the only section where one can cross the river to access interior valleys of Lankapuri.
- A pucca forest-chowki with watchtower needs to be erected at Bāling Sow, a large dwar along the left bank of Chikap Gad (inner valley of Lankapuri) for regular stay and monitoring by FD staff. This is very important as Lankapuri forests offer probably the best of wildlife habitats in the entire Sanctuary and seem to hold good numbers of species like Black bear, Serow, Goral, and Musk deer. This is also the locality where *guchchi* mushroom collectors throng in big numbers during monsoons.
- There is an old stone bunker (now in a dilapidated state) along the Lankapuri Ghad just 100 m before one crosses the river from Salaring village side. This can be revived as it offers an ideal monitoring site and resting camp for patrols.
- The trek-route from Salaring Village to Upper Phuphal Ghad alpine meadows is aligned along the riverbank in the beginning; this stretch is now characterized by heavy rock falls which block the route on several places. This stretch of the trail

needs to be realigned high up the ridge to avoid the rock falls. The trail becomes very narrow and precipitous just after Daeksham (c. 250 m before the merger of Sumti Ghad with Phuphal). There is little maintenance. This path needs to be broadened and maintained regularly for easy access to Upper Phuphal Ghad alpine meadows.

Bhaba Valley:

- There is no Forest Rest House at Katgaon or Kafnu for visiting officials or tourists to stay. Though the Himachal Pradesh State Electricity Board's Guest House at Katgaon is temporarily used by the sanctuary authorities, it is important for the management to have its own independent rest house. With a recent spurt in arrival of ecotourists and trekkers in Bhaba Valley, it would be a profitable venture for FD to own a Tourist's Guest House at Katgaon.
- A nature interpretation centre that focuses on high-altitude alpine ecosystem and climate change can be opened up in Katgaon for the benefit of the visitors and tourists. This can also be developed as a centre of environmental education for the region's students and public.
- One of the widespread and persistent demands of people of Bhaba Valley includes one for a jeepable, all-weather road from Kafnu till Mulling or Aingar Gad (just outside the sanctuary limits). A survey was earlier undertaken by both PWD and Forest Dept and it was found that this road construction would involve cutting down of 419 trees. In this regard, PWD has prepared a proposal along with tentative budgetary estimate and sent it to Forest Dept for approval during 2005-06. The file was apparently pending with the Forest Dept. Local people are well aware of these developments and there is a general feeling of resentment among them against the Forest Dept in this regard. This road is very important for the sanctuary management as well, as it is critical for regular patrolling and monitoring of the sanctuary. This will also generate immense goodwill towards Forest Dept among the local communities. Of course, this road will also open up the region, and that means new settlements, heavy influx of tourists, and more livestock grazing. Therefore, the sanctuary authorities should have a clear policy and protocol along with requisite human resources to regulate movements inside Bhaba valley before any such road comes up. Some people whom we spoke to even demanded that this proposed road be extended up to Kaza (Pin Valley) as huge number of shepherds and traders traditionally use this trek to reach Kaza from Mulling. But this is clearly unacceptable, as this road would cut through the core sanctuary holding some of the pristine alpine habitats and may bring about disastrous consequences for wildlife populations and their critical habitats.

- A transit camp should be opened at Homtee Thatch on way from Kafnoo to Mulling for the benefit of the sanctuary staff, trekkers and wildlife tourists.
- Chokka Pani Spring near Gyare forest is famous for its sweet water and being a prominent resting place for trekkers, this can be developed as another transit camp for people heading towards Upper Bhaba Valley.
- The two semi-permanent subterranean bunkers at Mulling Pastures are now in a state of disuse and may be revived with pucca structures for patrolling and monitoring camps. Similarly there is another ramshackle underground bunker at Kara Pastures constructed by the sanctuary management and this also needs to be revived for forest patrol parties to stay.

Listegarang Valley:

- There is a fairly recent Guard's Quarter (meant for the Beat Guard of Shango Beat) at the end of the Shango village. This now lies in a state of disrepair, and it is in immediate need of renovation with proper water and electricity connectivity.
- There is an old wooden bridge across the Listegarang River at Sumādé dogri, and one has to cross this bridge to enter the sanctuary. Local villagers claim that the sanctuary limit begins just after the wooden bridge, though FD personnel have no clues. It brings to the fore an important management issue of field-demarcation of sanctuary boundaries. Priority should be given to erection of stone-pillars at regular intervals (at least along trekking routes and access paths) as mark of sanctuary boundaries.

6.3 Ecotourism Initiatives

Though Rupi Bhaba Sanctuary has enormous potential for wildlife and adventure tourism on account of it being the stronghold of some of the spectacular wildlife species of western Himalaya like Western Tragopan, Serow, and Himalayan Tahr, and being a mountain landscape with precipitous hills and deep narrow gorges, there are hardly any signs of such activities in the sanctuary barring a few recent initiatives by private tourism firms in Bhaba Valley. In particular, the spectacular diversity of birds like the nine species of galliformes, three species of rare snipes that occur only in high-altitude bogs of montane forests, and ten species of leaf-warblers would make Rupi Bhaba Sanctuary a birding hotspot. This would also attract the foreign birders and wildlife enthusiasts who throng GHNP and Pin Valley in great numbers every year to Rupi Bhaba. Eco-tourism, while it can generate opportunities to raise income for local communities and sanctuary management, can also be a bane

if not regulated. We provide here some possible outlines for taking up responsible eco-tourism initiatives in the sanctuary.

6.3.1 Management Prescriptions

- The following trails can be considered for opening up to wildlife/birding tourists in the sanctuary as part of eco-tourism initiatives.
    - Rupi FRH to Gaukanda Dhar: 3 km. 2450-2875 m altitude. Main wildlife species include Koklass, Himalayan Monal, Goral, and Flying Squirrels. The existing trail needs to be maintained as bridle-path.
    - Rupi FRH to Shamno Dhar: 5 km. 2450-3000 m altitude. Notable for sighting of Koklass, Himalayan Monal, Leaf-warblers, Musk Deer, and Black Bear. Excellent camping ground for overnight stay with tents.
    - Rupi FRH to Dumti (Upper Shorang Valley): 13 km. 2450-3070 m altitude. Rich in species like Himalayan Monal, Western Tragopan, Serow, Musk Deer, and Common Leopard. Camping facilities can be developed at Dumti or surrounding pastures. The return can be along the left bank of the Shorang River to Shorang village (next trail).
    - Dumti to Shorang / Chota Kamba: 11 km. 2300-2700 m altitude. Very scenic riverine landscape with waterfalls and good wildlife populations mainly Koklass, Serow, and Common Leopard. Stay at PWD RH at Bara Kamba.
    - Chota Kamba to Yurang Dhar: 5 km. 2100-3800 m altitude. Known for the high alpine areas of Yurang Dhar, a high peak. The trail goes through some of the best patches of coniferous forests that harbour Western Tragopan, Himalayan Monal, leaf-warblers, Goral, Serow, Musk Deer, and Common Leopard. Yurang Dhar has alpine species like Himalayan Snowcock, Himalayan Weasel, and pikas. The last 2 km trail nearly non-existent after Shal Thatch and needs to be maintained. Camp at Shal Thatch before one climbs the steep Yurang Dhar (a 800 m climb).
    - Katgaon to Mulling pastures of Bhaba Valley: 14 km. 2430-3200. One of the popular alpine landscapes in the sanctuary. Vast and spectacular pasture lands. Ideal for mountain tourism though wildlife sightings will be very minimal owing to livestock presence. Lots of camping sites available. Private adventure tour firms now operate here.

- However, some of the valleys where pristine wildlife habitats exist should not be opened up for tourism. These inviolate areas include Upper Shorang Valley beyond Dumti, Lankapuri and Phupal Gad Valleys and alpine landscape beyond Mulling in Bhaba Valley.
- Local guides should be enlisted as official tour and trek guides and income generated can be disbursed through co-operative venture. These co-operatives should be managed by the local communities themselves.

6.4 Interdepartmental Interactions

The mountainous district of Kinnaur, where Rupi Bhaba Sanctuary is located, is naturally the focal point of several government-sponsored schemes and projects for the economic upliftment of the local people, a majority of whom is living below poverty line. Since a large part of the district is designated as forest land (contra revenue areas), government development agencies find it difficult to implement their schemes and this frequently results in increased conflict of interest between the Forest Department and other state departments. For example, the long-standing demand of the locals in Bhaba Valley for extension of the Wanger-Kafnu road to Mulling is caught between the Forest Dept and Public Works Dept.

Other state agencies like Departments of Animal Husbandry, Horticulture, Health, Irrigation and Public Health, Revenue, and Tourism are active in the buffer zone of the sanctuary. There are several schemes currently being implemented in the region under the aegis of these departments. The hydel projects along the Sutlej are run by Sanjay Jal Vidyut Nigam (SJVN), a public limited company hosted by the Government of Himachal Pradesh.

6.4.1 Management Prescriptions

- Lack of communication between Forest Dept and other state agencies would be a major drawback for the sanctuary management as several development schemes are set to benefit the local communities socially and economically. The Sanctuary authorities should have regular interactions with the district representatives of other state departments to sort out their differences and to brief each other the programmes being planned.

6.5 Income Generation Opportunities and Mechanisms

As we stated before, it is imperative to wean away the local communities from forest-based livelihood for effective conservation of wildlife populations and their habitats. It can be done only by creating new genre of employment and income-generating opportunities, equitably across all strata of the society. This is evident from Rupi Bhaba Sanctuary, where pressure on forests is perceptibly low in Bhaba Valley in comparison to the Rupi Range. The establishment of hydel projects and subsequent infrastructure developmental works created new employment opportunities in Bhaba Valley, and recent shift in their cropping pattern to more lucrative apple orchards has generated a lot of agricultural income. These two factors have contributed to the growing clout of non-forest economy in Bhaba valley. Opening up of Bhaba Valley for mountain and adventure tourism has again created a new avenue of income generation for the local people. On the contrary, people in Rupi and Shorang Valley continue to be wholly dependent on forestry resources for their sustenance, exerting huge pressure on forests and wildlife populations in the core of the sanctuary. With agriculture largely confined to sustenance farming and lack of opportunities for raising non-forest income, villages in Rupi Valley are dependent on forests for their livelihood and their use and extraction of forestry resources are often well beyond sustainable limits.

Though Mahila Mandals (women's self-help organizations) are actively present in nearly every village of the buffer zone, they are currently not sufficiently innovative to find revenue-creating opportunities from non-forestry sector. Lack of counsel and leadership, traditional absence of social entrepreneurship in these communities, and a misplaced perception of forests as limitless resources of income are some of the factors why these Mahila Mandals are not very successful vehicles of local level economic change.

6.5.1 Management Prescriptions

- It is in the long-term interest of the sanctuary that new avenues of income generation for people in Rupi Valley villages be explored and adopted. Forest department should co-ordinate with other state agencies active in the region to facilitate implementation of their economic stimulus packages in the villages of Rupi, Shorang, and Salaring Valleys. These may include eco-tourism initiatives, shift in cropping pattern to commercial crops like high-value fruits, apiculture, handicrafts, and commercial forestry.

- Self-help groups like Mahila Mandals should be properly guided for raising their own income and should co-ordinate with the proposed village forest committees.
- Centrally-sponsored rural economic schemes like Jawahar Rozgar Yojana (JRY) and National Rural Employment Guarantee Act (NREGA) should be implemented in the villages of the buffer zone; this would also enable the sanctuary management to take up the infrastructure development works in the buffer zone.

6.6 Financial Outlay and Budgetary Allocations

A summary of management proposals and the expected amount of financial outlay required for each of the proposal have been presented in the Table 12. We envisage a total amount of about Rs. 959.95 lakhs (i.e. 9.6 crores) as the total budgetary allocation for the management plan period of five years from 2010 to 2015. Out of this, an outlay of Rs. 713.3 lakhs (i.e. 7.13 crores) has been earmarked for non-recurring expenditure, and Rs. 246.6 lakhs (i.e. 2.47 crores) for recurring expenditure. A minimum of 12% per year should be allowed as hedge against inflation and this should be added to the total budget under each head.

Table 12. A summary of proposed expenditure and financial outlay for the Management Plan period of 5 years (2010-11 to 2014-15).

S. No.	Head & Activity	2010-11	2011-12	2012-13	2013-14	2014-15	Total
I	**NON-RECURRING EXPENDITURE**						
A	**Construction of Buildings**						
1	Construction of visitor centre at Chota Kamba	16.00					16.0
2	Construction of nature education centre at Katgaon	15.00					15.0
3	Construction of Forest Rest House at Chota Kamba		20.00				20.0
4	Construction of Forest Rest House at Katgaon		20.00				20.0
B	**Construction of Patrol Infrastructure**						
1	Construction of forest chowki at Dumti			6.00			6.0
2	Construction of bunkers		2.00	2.00	2.00	1.00	7.0
3	Construction of watch towers	4.00		4.00	2.00		10.0
4	Construction of new foot-bridges across Chikap Gad and Upper Shorang			6.00			6.0
5	Construction of check-posts	1.00	1.00	1.00	1.00		4.0
C	**Office & Transport Infrastructure**						
1	Vehicles*	7.00	1.40	9.00	2.00	2.00	21.4
2	Infrastructure at HQ	4.00		2.00	1.00	1.00	8.0
3	Infrastructure at Range Offices	4.00	1.00	1.00	1.00	1.00	8.0

4	Infrastructure at Beat/Block offices	18.70	1.60	1.00	1.60	1.00	23.9
D	**Repair of Existing Infrastructure**						
1	Repair of Guard Quarters at Shorang	1.00					1.0
2	Repair of Guard Quarters at Shango		2.00				2.0
3	Repair of defunct trails, paths, and foot-bridges	9.00	5.00	5.00	5.00	10.00	34.0
4	Repair of boundary-pillars		2.50			2.00	4.5
5	Repair/Erection of signage	0.50	0.50	0.50	0.50	0.50	2.5
E	**Protection Measures**						
1	Fire-control operations	1.00	1.00	1.00	1.00	1.00	5.0
2	Anti-poaching operations	4.00	4.00	4.00	4.00	4.00	20.0
F	**Habitat Maintenance**						
1	Pasture maintenance	0.20	0.20	0.20	0.20	0.20	1.0
2	Soil conservation works	6.00	11.00	11.00	11.00	11.00	50.0
3	Plantations & nursery	4.50	9.50	9.50	9.50	12.50	45.5
4	Eradication of weeds	3.00	4.00	4.00	4.00	4.00	19.0
G	**Wildlife Health**						
1	Wildlife health surveys & sampling	3.00	3.00	3.00	3.00	3.00	15.0
2	Tools, equipment, & medicine for capture, isolation, and treatment of animals	8.00	10.00	5.00	5.00	5.00	33.0
3	Vaccination of livestock	1.00	1.00	1.00	1.00	1.00	5.0
H	**Eco-tourism Initiatives**						
1	Eco-tourism infrastructure**	1.00	10.00	10.00	3.00	2.00	26.0
2	Guides & cooperatives	1.00	1.00	1.00	1.00	1.00	5.0
3	Training of eco-guides	1.00	2.00	1.50	1.00	1.00	6.5
I	**Research & Monitoring**						
1	Wildlife census operations	3.00	3.00	3.00	3.00	3.00	15.0
2	Herbarium	1.00	1.00	1.00	1.00	1.00	5.0
3	Estt. of enclosures in alpine meadows & pastures		3.00	1.50	3.10	3.10	10.7
4	Data storage & processing	3.00	2.00	2.00	2.00	2.00	11.0
5	Library & field guides	0.50	0.10	0.10	0.10	0.50	1.3
6	Field equipments (camera, GPS, binoculars, compass, range finder, etc)	3.00	15.00	5.00	5.00	5.00	33.0
7	Training and workshops for frontline staff	2.00	2.00	2.00	2.00	2.00	10.0
8	Maintenance of weather station at Sarahan	0.50	0.50	0.50	0.50	0.50	2.5
9	Research Projects (Appendix 13)	30.00	30.00	30.00	30.00	30.00	150.0
J	**Extension & Ecodevelopment**						
1	Repair of existing jhullas		0.50				0.5
2	Publicity materials for sanctuary	0.50	0.50	0.50	0.50	0.50	2.5
3	Nature education programme	0.50	1.00	0.50	0.50	0.50	3.0
4	Village forest committees and their expenses		0.50		0.50		1.0
5	Provisioning of saplings and technical expertise for raising community forests	0.50	0.50	0.50	0.50	0.50	2.5

6	Provisioning of basic infrastructure to villages in the buffer zone***	5.00	5.00	5.00	5.00	5.00	25.0
	Sub Total	*163.40*	*178.30*	*140.30*	*113.50*	*117.80*	*713.30*
II	**RECURRING EXPENDITURE**						
A	Salary components, office expenses and allowances	31.50	34.70	38.20	42.15	46.60	193.2
B	Maintenance of office buildings	1.50	1.50	1.50	1.50	1.50	7.5
C	Maintenance of vehicles	0.50	0.50	0.75	0.75	0.75	3.3
D	Maintenance of FRH		4.00	1.00	0.50	0.50	6.0
E	Maintenance of boundary pillars	0.25	0.25	0.25	0.25	0.25	1.3
F	Maintenance of paths, trails and foot-bridges	8.00	5.00	5.00	10.00	5.00	33.0
G	Maintenance of jhullas	0.50	0.50	0.50	0.50	0.50	2.5
	Sub Total	*42.25*	*46.45*	*47.20*	*55.65*	*55.10*	*246.65*
	GRAND TOTAL	205.65	224.75	187.50	169.15	172.90	959.95

* 5 100cc bikes, 2 4WD jeeps and 1 mini-bus

** Development of eco-tourism camps in Rupi Bhaba WLS

*** Potable water, approach road, play ground for schools, crematorium, etc

Chapter 7. Road Map [2010 - 2015]

7.1 Synthesis of Problems and Prospects

Rupi Bhaba Wildlife Sanctuary can be stated to be riddled with challenges from within as well as from the outside forces. Remoteness and characteristic rugged terrain have kept the management low key, particularly when the headquarters is located far away at Sarahan. The internal problems largely stem from poorly equipped staff and almost non-existent infrastructure, which directly limit the management effectiveness. The external problems are a mix of livelihood related activities and development projects along the Satluj River. Significantly, informed decisions are hardly possible on account of virtual absence of empirical information on biodiversity character of the area, and the intensity of biotic pressures on the Sanctuary's flora and fauna. There is growing resentment among the local communities due to crop depredation by wild ungulates and killing of sheeps & goats by carnivores, and that there is no conflict resolution mechanism in place to the satisfactory level. This Sanctuary is clearly among the least studied mountain protected areas in the state, and there is no strategic monitoring mechanism to understand the responses shown by the wildlife. The key problems that plague the Sanctuary are as follows;

- Given the remoteness and size of the Sanctuary, the number of staff sanctioned for the area is on the lower side.
- Limited quality of staff in terms of education level and appropriate training inputs, except the few new recruits.
- Logistics and infrastructure support for the field staff and supervising officials are poorly established.
- The staff lack basic equipments and education materials relevant for wildlife management.
- Dependency of local communities on the area is substantial similar to many other mountain protected areas.
- With improvement in the road network leading to increased agriculture/horticulture opportunities, conflicts also increase due to crop depredation and killing of livestock by wild animals.
- Although banned, managing livestock grazing is a challenging task, and in the absence of any credible information on the livestock-habitat interaction, it is difficult to gauge the consequences of livestock grazing or nongrazing here.
- Information on biodiversity components is grossly lacking, and that the management objectives are constrained by this lack of knowledge.

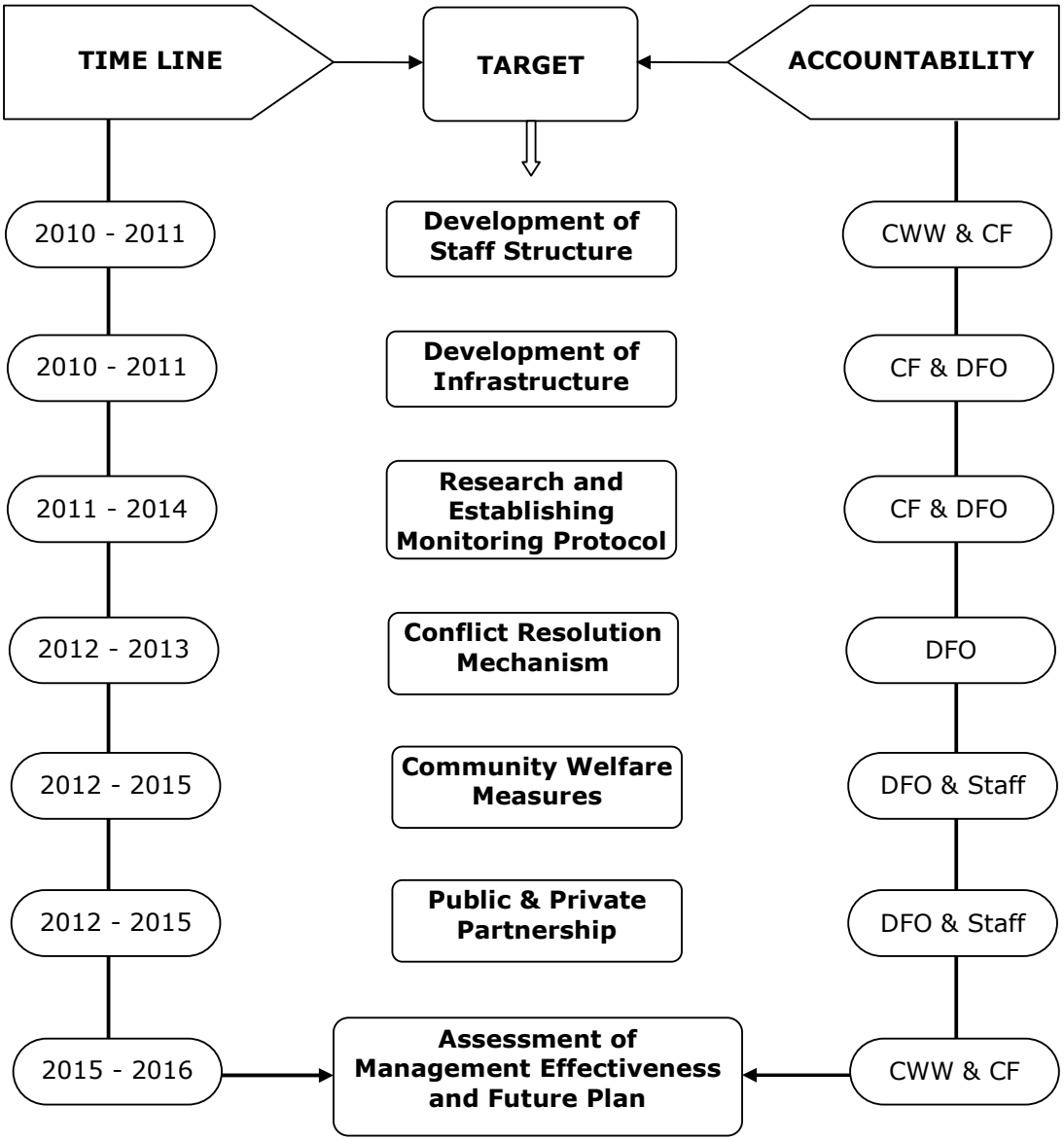
- Research has not found a place in the Sanctuary, except for some short surveys, and therefore, there is no targeted activity.
- Monitoring is adhoc, and there is a clear need for scientifically sound monitoring protocol.

While the problems are many, the Sanctuary is an important mountain PA, that promises future for mountain wildlife, largely attributed to remote and rugged terrain, and absence of villages in the core area - all the 28 villages are dotted only along the southern boundaries, closer to Sutlej River and motor road. It is fortuitous that the opportunities created by the development projects play a major role in reducing biotic pressure on the Sanctuary, by providing job opportunities and therefore, weans away the people from livelihood activities that are otherwise potential impediments for wildlife management. With modification in the existing infrastructure and staff support including dedicated DFO and ACF level officers with appropriate logistics within the Sanctuary, the management will take progressive step. The ecosystem services and goods offered by the Sanctuary to the local communities and others at large have already been recognized by many, but are required to be communicated to local communities and the development planner so that the basic elements are nor eroded and that preserved for posterity. Opportunity for ecotourism is unbounded and this would not only create revenue for Sanctuary management, but would simultaneously harness popular support for the welfare of the area. Research and monitoring, if undertaken on the target groups/activities suggested in this plan, would put the management on right course similar to already established mountain PAs in the state. Catchment Area Treatment (CAT) Plan supported by the compensatory money from the private development projects has hugely enhanced the fiscal opportunity. In addition, the private companies can be mandated to rehabilitate the area under their control and surrounding areas, with planting of native vegetation for improving biodiversity values, which can be jointly managed by the Sanctuary management and company owners.

7.2 Short Term and Long Terms Goals

Any 'Protected Area' as defined by the IUCN World Commission on Protected Areas (WCPA) relates to '***an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or otherwise effective means***'. This sets the agenda for long-term goal of managing the Sanctuary. However, the long term goal is frequently expected to serve the local and national agendas of wildlife management, as demanded by the legal framework

towards public welfare measures. In order to achieve this goal effectively, a series of short-term goals are important, which needs to be followed up religiously. Many of the short term targets are essentially the problems that have been identified during the plan exercise, and resolving each of these in an orderly trend would form the required node for a road map to fix the management focus. Further, proactive measures reflecting visionary approach would add values to the way the Sanctuary is managed and taken forward. In the end, all the goals are aimed at societal interest, and therefore, a considerate and inclusive approach would provide strong foundation for executing the management plan effectively. The flow chart depicts the proposed plan of action along with timeline for the coming five years. Protection is an integral part of the management, and it is not a targeted activity, rather a regular feature of management functioning.



7.3 Evaluation of Options, Initiatives and Achievements

The management has only a limited option in the current format of management strategy, which is more reactive than proactive. Prior to embarking on the management plan, it would be very useful to have an in-house SWOT analysis at the micro scale to the level of implementation. Recent recruitment of staff with credible qualification into the Forest Department is a welcome addition, and with specific training inputs, this workforce will effectively enhance the management effectiveness. The Sanctuary management has undertaken certain programs targeting habitat improvement, forest and wildlife protection, eco-development and infrastructure development. However, many of these have met with limited success owing to obvious reasons related to knowledge gap, motivation of staff, lack of clear objective, logistics and financial constraints. However, there is willingness to move beyond the conventional approach and engagement with local people and private companies are beginning to yield fruits. This is one area where further efforts are required in a target oriented and time bound manner. Overall, the Rupi Bhaba Wildlife Sanctuary can make a fresh beginning, riding on the past experiences and new scientific inputs.

7.4 Future Directions

It is very necessary to spell out a clear target for each of the year, and budget allocation and incentives should be linked to the success and failure of the target activities. Science must play a major role as it is non-existent at the moment, and that it would be important to engage an Institution with credibility as a collaborator to execute management objectives in a phased manner, until a workable capacity is developed within the Sanctuary. Although the area is managed under two Ranges, it would be worthwhile to consider taking the future management focussing on different catchments, and reorganization of beat boundaries could be carried out with this approach. Setting up of a dedicated squad for dealing with poaching and illegal wood cutting would be critical at some point in time. Forest - human interface issues are to be handled with soft hands, particularly on the issue of livestock grazing, wherein there is no clear understanding of the impact and the extent. The future strategy can look into regulated eco-tourism for generating revenue, strengthening environment education, and building partnership with local communities and private companies that are active in the area. Finally, much of the efforts should get translated into ecosystem services and goods in quantitative terms such that the case for better management receives adequate support from public, policy makers and market forces.

Bibliography

Bajpai, S.C. (1991). Kinnaur: A Restricted Land in the Himalaya. Indus Publishing Co., New Delhi.

Canterbury, G.E., T.E. Martin, D.R. Petit, L.J. Petit, and D.F. Bradford (2000). Bird communities and habitat as ecological indicators of forest condition in regional monitoring. *Conservation Biology*, 14:544-558.

de Groot, R.S., M.A. Wilson, and R.M.J. Boumans (2002). A typology for the classification, description and valuation of ecosystem functions, goods, and services. *Ecological Economics*, 41:393-408.

Hamilton, L. and L. McMillan (2004). Guidelines for Planning and Managing Mountain Protected Areas. IUCN World Commission on Protected Areas, IUCN, Gland, Switzerland.

Jishtu, V., G.S. Goraya, and G.S. Rawat (2007). Flora of Rupi-Bhaba Wildlife Sanctuary: A checklist. Journal of Economic and Taxonomic Botany, 31:953-974.

Kittur, S. and S. Sathyakumar (2005). A survey of status and distribution of the Himalayan Tahr (*Hemitragus jemlahicus*) in the Western Himalaya. Draft Report. Wildlife Institute of India, Dehradun.

Kumar, R. (2000). Working Plan for the forests of Kinnaur Forest Division (1999-00 to 2014-15). Forest Dept., Govt. of Himachal Pradesh, Shimla.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, and J. Kent (2000). Biodiversity hotspots for conservation priorities. Nature, 403:853-858.

Nair, N.C. (1977). *Flora of Bushahr Himalayas*. International Bioscience Publishers, Hissar.

Pandey, S. (1991). Management Plan for Rupi Bhaba Wildlife Sanctuary (1990-91 to 2001-02). Forest Dept., Govt. of Himachal Pradesh, Shimla.

Price, T., J. Zee, K. Jamdar, and N. Jamdar, 2003. Bird species diversity along the Himalaya: A comparison of Himachal Pradesh with Kashmir. *Journal of Bombay Natural History Society*, 100:394-410.

Rawat, G.S. (2007). Status survey of the alpine meadows of Western Himalaya. Wildlife Institute of India, Dehradun.

Rodgers, W.A. and H.S. Panwar (1988). Planning a Wildlife Protected Area Network in India. Wildlife Institute of India, Dehradun.

Rodgers, W.A., H.S. Panwar, and V.B. Mathur (2002). Wildlife Protected Area Network in India: A Review. Wildlife Institute of India, Dehradun.

Round P.D., B. Hansson, D.J. Pearson, P.R. Kennerley, and S. Bensch, 2007. Lost and found: the enigmatic large-billed reed warbler *Acrocephalus orinus* rediscovered after 139 years. *Journal of Avian Biology*, 38:133-138.

Sanan, D. and D. Swadi (1998). Exploring Kinnaur and Spiti in the Trans-Himalaya. Indus Publishing Co., New Delhi.

Sinha, S.K. (1975). Wildlife losses due to diseases in Indian wild animals. *Cheetal*, 17(2):25-38.

Glossory

Local Terms in Kinnaur and Sutlej Valley (Largely taken from Kumar, 2000)

Local name	English equivalent
abadi	A village settlement
adna malik	Sub-owner of a property
ala malik	Superior owner of a property
badhan gani	A tax levied in old Bushahr State
bahan	Floating of timber
balli	Round unsawn timber
bartan	Rights of user
bartandar	An individual who enjoys the rights
baoli	A small water spring
banjar	Wasteland
bakhal	Unirrigated cultivable land
chhanda	Riverine islets
chaukidar	Watchman and caretaker of a building
coolie	Labourer
charand	Grazing land
chhang	Lopping of canopy for fodder
chohade	A pillar where boundaries of four villages meet
danda	A high level ridge
darat	A local sickle used in lopping
dehat	Village
deota	The village deity
dogri	A semi-permanent shepherd camp with cultivation
dhar	A spur or a ridge. Also refers to alpine pasture
gad	A small stream with perennial water
ghall	Timber floating in stream or river
ghrat	Flour mill run by water
ghasni	Grassy patch where grasses are cut from
ghati	Mountain pass in a ridge
gujjar	A nomadic buffalo grazier
jagirdar	Owner of estate or grant or property
jhulla	A mechanized ropeway across rivers
jungle mefusa	Reserved forest
jungle mahduda	Demarcated protected forest

Local name	English equivalent
kanda	Alpine meadow or pasture used for cattle grazing
khad	A small perennial stream (often same as gad)
kharif	Rainy season crop
Kanawar	Old name for Kinnaur
kuhl	A water channel
lambardar	Village headman
mali	Gardener and nursery in-charge
mandi	Market
mazdoor	Labourer
mela	Local fair
moawza	Compensation
nalla / nala	Water-course or small stream
nautod	Forest land granted for fresh cultivation
panchayat	Village administrative council
panwi	A grassland burnt annually during winter
pattoo	Blanket
patti	Locally made woollen cloth
rabi	Winter crop
rawana	permit for exporting forest produce
sarnai	An inflated goat/buffalo skin used to cross rivers
shamlat	wasteland owned by villages
suhr	Fallen pine needles
tal	Lake
thatch	A grassy blank on ridges used for grazing livestock
tibba	Peak
timi	Grazing tax
zamindar	Land owner assessed for land revenue

Appendix 1. Administrative subdivisions of the core area of Rupi Bhaba Wildlife Sanctuary (excluding buffer zone) indicating their area, boundaries, and pasture jurisdictions.

Range	Block	Beat	Forests *	Area (ha)	Beat Boundaries	Pasture mgt
I. Rupi	Chota Kamba	Chota Kamba	UF-16	92.00	N – Kamba Khango	Pastures of Barkyo and Kumrang
			UF-17	158.00	E – Yurang Dhar	
			C-95	7.28	W – Garsim Pota Dhar & footpath to Kamba Khango	
			C-96	65.15	S – Sutlej River	
		Bara Kamba	UF-11	570.00	N – Barkyo Dhank	
			UF-12	302.00	E – Garsim Pota Dhar	
			UF-13	240.00	W – Shorang Gad	
			UF-14	180.00	S – Sutlej River	
			UF-15	320.00		
		Shorang	UF-7	300.00	N – Boundary of Spiti & Kinnaur	All the pastures in the beat
			UF-8	390.00	E – Footpath to Kamba Khango	
			UF-9	435.00	W – Shorang Gad	
			UF-10	490.00	S – Dumti	
			C-97	28.00		
	Rupi	Shamno	UF-1	267.00	N – Tikada Gad	
			UF-2	17.50	E – Tikada Gad	
			UF-6	472.00	W – Main Srikhand Dhar	
					S – Sutlej River	
		Rupi	UF-3	872.00	N – Skamdal pasture	Skamdal pasture
			UF-4	80.00	E – Churing Dhar	
					W – Tikada Gad	
					S – Sutlej River	
		Dabling	UF-5	87.50	N – Boundary of Spiti & Kinnaur	Pastures of Palit and Dampal
			C-98	78.00	E – Shorang Gad	
			C-99	3.00	W – Ghurring Dhar	
					S – Sutlej River	

Range	Block	Beat	Forests *	Area (ha)	Beat Boundaries	Pasture mgt
II. Katgaon	Katgaon	Katgaon	UF-27 C-90 C-91	425.00 9.31 510.71	N – Sholing Nala E – Wanger Gad W – Sholing Dhar, Katgaon Kand, Bai Kanda down to Sutlej River S – Sutlej River	
		Homte	Pastures between Sholing Nala & right bank of Wanger Gad, and between left bank of Nickigarang & right bank of Khanta Nala		N – Boundary of Spiti and Kinnaur E – Khanta Nala and Wanger Gad up to Homte W – Sorgang Dhar, Nickigarang up to Shakarog Khango S – Sholing Nala	All the pastures in the beat
		Yangpa	UF-28 UF-29	417.00 345.00	N – Boundary of Spiti and Kinnaur E – Ridge separating watershed of Listigarang Gad and Wanger Gad W – Khanta Nala S – Wanger Gad	All the pastures in the beat
		Shango	UF-30 UF-31	687.00 415.00	N – Boundary of Spiti and Kinnaur E – Chikim Dhar and Mukim Dhar W – Ridge separating watershed of Listigarang Gad and Wanger Gad S – Kangarang Gad	All the pastures in the beat
		Kangarang	UF-32 C-87 C-88 C-89	220.00 196.27 242.00 124.64	N – Kangarang Gad E – Mukim Dhar down to Sutlej W – Wanger Gad S – Sutlej River	

* The following Undemarcated Forests and Compartments fall under the buffer zone of the sanctuary: UF-18, UF-19, UF-20, UF-21, UF-22, UF-23, UF-24, UF-25, UF-26, C-92, C-93, & C-94.

Appendix 2. A list of staff-housings inside Rupi Bhaba Wildlife Sanctuary.

Sl. No.	Name of buildings	Number	Remarks*
	I. Rupi Forest Range		
1.	Range Office cum residence, Rupi	one	old (in poor state)
2.	Forest Guard hut, Rupi	two	one old & one new
3.	Forest Guard hut, Shorang	one	new (but damaged by rockfall)
4.	Forest Guard hut, Chota Kamba	one	old
5.	Deputy Ranger quarter, Chota Kamba	one	old
6.	Deputy Ranger quarter, Salaring	one	new (under construction)
7.	Forest Guard hut, Salaring	two	one old & one new under construction
8.	Forest Guard hut, Nathpa	one	new
9.	Forest Guard hut, Kandhar	one	old
	II. Katgaon Forest Range		
1.	Range Office cum residence, Katgaon	one	new
2.	Deputy Ranger quarter, Katgaon	two	one old & one new
3.	Forest Guard hut, Katgaon	one	old
4.	Forest Guard hut, Yangpa	one	new
5.	Forest Guard hut, Shango	one	new (but in rundown state)

* Old buildings are those which were transferred from Nichar Forest Division when Wildlife Division was created at Sarahan. New buildings were constructed after the notification of the sanctuary in 1982.

Appendix 3. A list of existing trails and bridle-paths in Rupi Bhaba Wildlife Sanctuary along with their current status.

Sl. No.	Trek route	Length of the trail (km)	Current status of maintenance
1.	Chaura jhulla to Rupi FRH	13	Good
2.	Rupi FRH to Gaukanda Dhar	3	Partly maintained
3.	Rupi FRH to Shamno Dhar	4	Good
4.	Rupi to Chushu Pishu	22	Not maintained
5.	Rupi to Dumti	13	Partly maintained
6.	Dumti to Chota Kamba (via Shorang)	11	Good
7.	Chota Kamba to Yurang Dhar	5	Partly maintained
8.	Chota Kamba to Salaring	5	Good
9.	Chota Kamba to Shakdogri	16	Partly maintained
10.	Chota Kamba to Nigulsari jhulla	3	Good
11.	Chota Kamba to Sungra jhulla	3	Partly maintained
12.	Salaring to Baling-sow (Lankapuri)	4	Not maintained
13.	Salaring to Bhabanagar jhulla	3	Partly maintained
14.	Salaring to Nathpa jhulla	5	Partly maintained
15.	Nathpa jhulla to Kandhar	3	Partly maintained
16.	Katgaon to Mulling (Bhaba Valley)	13	Good
17.	Mulling to Kara Pasture (Bhaba Valley)	5	Not maintained
18.	Katgaon to Khasyan (Listigarang)	6	Partly maintained
19.	Shango to Chogam	12	Partly maintained

Appendix 4. A list of villages located in the buffer zone of the Rupi Bhaba Wildlife Sanctuary and details of community infrastructure and public amenities in each village.

S. No.	Village	Institutions
	I. RANGE: KATGAON	
1.	Kangrang	Primary school
2.	Dutrang	Primary school
3.	Shango	Primary school and Angan bari
4.	Bai	Primary school and Mahila mandal bhawan
5.	Katgaon	High school, Veterinary hospital, Patwar khana, Ayurvedic hospital, Civil dispensary, Horticulture office, Police outpost, Wildlife range office, Angan bari, Mahila mandal bhawan, Panchayat ghar, Post office, Mahila prashikshan centre, JE (HPSEB), Electricty board office, Gram sewak office, Bee-keeping station, and Bhaba hydel project.
6.	Surcho	Primary school, Asian Tech Ltd
7.	Kraba	Primary school, Angan bari, Mahila mandal bhawan, and Primary health centre
8.	Yangpa-I	Primary school, Middle school, Animal husbandry office, Civil dispensary, Primary health centre, Angan bari, and Mahila mandal bhawan
9.	Yangpa-II	Primary school, Mahila mandal bhawan, Bhaba hydel project, and Angan bari
10.	Huri	Primary school, Post office, and Angan bari
11.	Kafnoo	Primary school, Angan bari, Panchayat ghar, Patwar khana, and Asian Tech Ltd
12.	Homte	Primary school and Horticulture SI office
	II. RANGE: RUPI	
13.	Kandhar	Primary school, Mahila mandal bhawan, and Angan bari
14.	Nathpa	Middle school, Mahila mandal bhawan, Primary health centre, Patwar khana, Panchayat ghar, Veterinary dispensary, Post office, Staying hut (Revenue), and Gram prasar adhikari office
15.	Salaring	Staying hut (Forest), Block office (forest)
16.	Kachrang	Primary school and Night school
17.	Rokcharang	Primary school and Night school
18.	Gharsu	Primary school, Angan bari, Mahila mandal bhawan, and Proudh shiksha kendra
19.	Chota Kamba	Block office (Forest), Veterinary dispensary, Ayurvedic dispensary, Primary school, High school, Sub-Post office, Angan bari, Gram sewak office, Mahila mandal bhawan, and Proudh shiksha kendra
20.	Shorang	Primary school, Proudh shiksha Kendra, and Forest beat office
21.	Bara Kamba	Primary school, Angan bari, Proudh shiksha Kendra, Patwar khana, and Mahila mandal bhawan
22.	Dabling	Primary school
23.	Majgaon	High school, Veterinary dispensary, Ayurvedic dispensary, Patwar khana, Block office

S. No.	Village	Institutions
		(Forest), Range office (Forest), Mahila mandal bhawan, and Panchayat ghar
24.	Naling-I	--nil--
25.	Naling-II	--nil--
26.	Shagarcha	Primary school, Retail price shop, and Patwar khana
27.	Huruva	--nil--
28.	Gurguri	Sub-Post office

Appendix 5. A systematixc list of plants recorded from Rupi Bhaba Wildlife Sanctuary. The list is compiled from various sources including Kumar (2000), Jishtu et al. (2007), and our primary data from Bhaba Valley. Note that the plant families are given in alphabetical order and the taxa are arranged within each family according to their habits as follows: T-Trees, S-Shrubs, C-Climbers, H-Herbs, Sd-Sedges, and G-Grasses.

Family & Scientific name	Habit	Local name in Kinnaur Valley
Family: Acanthaceae		
Lepidagathis cuspidata	S	
Strobilanthes alatus	H	Mashna, Machin, Nashain
Strobilanthes atropurpureus	H	Mashna, Mashain
Strobilanthes dalhousianus	H	Machin, Mashian
Family: Amaranthaceae		
Bosia amherstiana	S	Khasbar
Family: Anacardiaceae		
Pistacia integerrima	T	Kakkar, Kakrian
Rhus wallichii	T	Hurku, Shush
Rhus corinus	S	Rikhal, Tung, Tugang
Rhus semialata	S	Titar, Titry
Family: Apiaceae		
Heracleum candicans	S	
Heracleum nepalense	S	
Carum carvi	H	Zeera
Foeniculum vulgare	H	Saunf
Selinum tenuifolium	H	
Family: Aquifoliaceae		
Ilex dipyrena	T	Kandru
Family: Araceae		
Arisaema flavum	H	
Arisaema jacquemontii	H	
Arisaema propinqum	H	
Family: Araliaceae		
Hedera helix	C	Grumru
Family: Asclepiadaceae		
Cynanchum auriculatum	H	
Vincetoxicum hirundinaria	H	
Family: Asteraceae		
Arctium lappa	S	
Artemisia maritima	S	Seski, Buer
Artemisia vestita	S	Seski, Buer
Artemisia vulgaris	S	Seski, Buer
Inula cappa	S	
Inula grandiflora	S	
Ainsliaea aptera	H	Durwa, Kalighati
Anaphalis arvensis	H	
Anaphalis nubigena	H	Bhujnu
Aster albescens	H	
Bidens wallichii	H	

Family & Scientific name	Habit	Local name in Kinnaur Valley
Carduus edelbergii	H	
Cremanthodium arnicoides	H	
Crepis japonica	H	
Echinops niveus	H	
Erigeron multiradiatus	H	
Gerbera lanuginosa	H	Kopra
Gnaphalium luteo-album	H	
Gynura angulosa	H	Kasiunga
Jurinea macrocephalla	H	Dhoop
Ligularia fischeri	H	
Saussurea lappa	H	Kuth, Koot
Senecio chrysanthemoides	H	
Tanacetum longifolium	H	Bhut kesi
Tanacetum nubigenum	H	
Taraxacum officinale	H	
Family: Balsaminaceae		
Impatiens amphorata	H	
Impatiens racemosa	H	
Impatiens roylei	H	
Impatiens scabrida	H	
Impatiens thomsoni	H	
Family: Berberidaceae		
Berberis aristata	S	Kashmal, Khepacho
Berberis chitria	S	Kashmal, Chutrum
Berberis kunawurensis	S	Kashmal, Chutrum
Berberis lycium	S	Kashmal, Chutrum
Podophyllum hexandrum	H	Bankakri, Papri
Family: Betulaceae		
Alnus nitida	T	Kunees, Kosh, Nyun
Betula alnoides	T	Sheori, Kathbhoj, Shagra
Betula utilis	T	Bhojpatra, Pad
Carpinus viminea	T	Khirkii, Lolti
Corylus jacquemontii	T	Sharol, Banshari, Ge bija
Family: Boraginaceae		
Cynoglossum macranthum	H	
Cynoglossum wallichii	H	
Hackelia uncinata	H	
Lindelofia longiflora	H	
Myosotis caespitosa	H	
Myosotis sylvatica	H	
Family: Brassicaceae		
Capsella bursa-pastoris	H	
Erysimum hieracifolium	H	
Erysimum melicentae	H	
Sisymbrium alliarea	H	
Family: Buxaceae		
Buxus wallichiana	T	Shamshad

Family & Scientific name	Habit	Local name in Kinnaur Valley
Sarcococca saligna	S	Taliary, Charabara
Family: Campanulaceae		
Campanula argyrotricha	H	
Campanula cashmiriana	H	
Campanula colorata	H	
Campanula latifolia	H	
Family: Caprifoliaceae		
Abelia triflora	S	
Lonicera angustifolia	S	Kantias, Pirlu
Lonicera quinquelocularis	S	Kantias, Pirlu
Viburnum coriaceum	S	
Viburnum cotinifolium	S	Taliana, Bhutool, Tustus
Viburnum nervosum	S	Tilenal, Talkha, Thalin
Viburnum stellulatum	S	Richhoi
Sambucus ebulus	H	Gandala
Family: Caryophyllaceae		
Arenaria bryophylla	H	
Cerastium cerastoides	H	
Cerastium dahuricum	H	
Gypsophila cerastoides	H	
Silene davidii	H	
Silene gonosperma	H	
Silene nigrescens	H	
Silene setisperma	H	
Silene vulgaris	H	
Spergularia marina	H	
Family: Celastraceae		
Euonymus tingens	T	Barmeli, Kalachindwara
Family: Chenopodiaceae		
Eurotia ceratoides	S	
Chenopodium album	H	Tulsi, Dankhar
Family: Clusiaceae		
Hypericum lysimachioides	S	
Hypericum cernuum	H	Banj wakra
Family: Convolvulaceae		
Porana racemosa	S	
Cuscuta reflexa	C	Akashabel
Family: Coriariaceae		
Coriaria nepalensis	S	Masuri, Lit zaklo
Family: Cornaceae		
Cornus capitata	T	Kareeva, Khagsha, Sak taquas
Cornus oblonga	T	Kareeva
Family: Crassulaceae		
Rhodiola heterodonta	H	
Rosularia rosulata	H	
Family: Cupressaceae		

Family & Scientific name	Habit	Local name in Kinnaur Valley
Cupressus sempervirens	T	Saru
Cupressus torulosa	T	Devidiar
Juniperus indica	T	
Juniperus macropoda	T	Guggal, Dhup, Shur
Juniperus recurva	S	Thaily, Guggal, Thailu
Family: Cyperaceae		
Carex alpina	Sd	
Carex aristata	Sd	
Carex cruenta	Sd	
Carex haematostoma	Sd	
Eleocharis palustris	Sd	
Isolepis setacea	Sd	
Kobresia nepalensis	Sd	
Family: Dioscoreaceae		
Dioscorea deltoidea	C	Kunj calendi, Singlimingli, Baniatakari
Family: Dipsacaceae		
Dipsacus inermis	H	Tori
Family: Elaeagnaceae		
Hippophae salicifolia	T	
Elaeagnus umbellata	S	Geai, Gehain, Surch
Family: Ephedraceae		
Ephedra gerardiana	H	Somlata, Khanta
Family: Ericaceae		
Pieris ovalifolia	T	Yarta, Ayar
Rhododendron arboreum	T	Baras, Parag
Gaultheria nummularioides	S	
Gaultheria trichophylla	S	
Rhododendron campanulatum	S	Kashmiri patha, Sirmang
Rhododendron lepidotum	S	Sumral
Monotropa hypopitys	H	
Family: Euphorbiaceae		
Andrachne cordifolia	S	Durlu, Bharti, Karkan
Family: Fabaceae		
Albizzia lebbek	T	Pangar
Robinia pseudoacacia	T	Pahari Kikar
Astragalus candolleanus	S	
Astragalus rhizanthus	S	
Caragana brevispina	S	Shameh
Caragana gerardiana	S	
Colutea nepalensis	S	Seena, Shulu
Desmodium sambuense	S	Safed kathi
Desmodium tiliaefolium	S	Mortoi, Mus
Flemingia fruticulosa	S	Chopru
Flemingia prostrata	S	
Indigofera dosua	S	Kathi, Kanthi

Family & Scientific name	Habit	Local name in Kinnaur Valley
Indigofera gerardiana	S	Kathi, Kanthi
Indigofera hebepetala	S	Kathi, Kanthi, Kastiarang
Indigofera heterantha	S	Kathi, Kanthi
Indigofera pulchella	S	Kathi, Kanthi
Piptanthus nepalensis	S	Chamboa
Hedysarum cachemirianum	H	
Hedysarum microcalyx	H	
Parochetus communis	H	
Thermopsis barbata	H	
Trifolium pratense	H	Kuth
Trifolium repens	H	
Trigonella emodi	H	
Family: Fagaceae		
Castanea sativa	T	Mitha Khanor, Poo
Quercus ilex	T	Breh
Quercus leucotricophora	T	Ban, Bani
Quercus semecarpifolia	T	Kharsu, Kor
Family: Gentianaceae		
Gentiana argentea	H	Nili sarnal
Gentiana kurroo	H	Karu, Kore
Gentianella paludosa	H	
Halenia elliptica	H	Pitpapra
Swertia chirata	H	Charaita
Swertia cordata	H	Charaita
Swertia paniculata	H	Charaita
Family: Geraniaceae		
Geranium nepalense	H	Tirrahani
Geranium ocellatum	H	
Geranium pratense	H	
Geranium robertianum	H	
Geranium wallichianum	H	Chowhri
Family: Iridaceae		
Iris kemaonensis	H	
Family: Juglandaceae		
Engelhardtia colebrookiana	T	Samma
Juglans regia	T	Khor, Akhrot, Ka
Family: Lamiaceae		
Colebrookia oppositifolia	S	Bhamber
Elsholtzia polystachya	S	Pothi jaunkra
Perowskia atriplicifolia	S	
Plectranthus coetsa	S	Bangra
Plectranthus rugosus	S	Chhichhri, Piyag
Roylea calycina	S	Kamol titpati
Calamintha umbrosa	H	
Leonurus cardiaca	H	
Mentha sylvestris	H	Podina
Nepeta ciliaris	H	Brun

Family & Scientific name	Habit	Local name in Kinnaur Valley
Nepeta elliptica	H	
Nepeta erecta	H	
Nepeta laevigata	H	
Origanum vulgare	H	
Phlomis bracteosa	H	
Phlomis spectabilis	H	
Rabdosia rugosa	H	
Salvia glutinosa	H	Gwadra
Salvia lanata	H	Gwadra
Thymus serpyllum	H	Ban jewain
Family: Lauraceae		
Litsea consimilis	T	Paror, Chirindi
Litsea umbrosa	T	Paror, Chirindi
Machilus duthiei	T	Chan, Chirindi
Family: Liliaceae		
Asparagus filicinus	H	Sahasimuli
Polygonatum cirrhifolium	H	
Polygonatum verticillatum	H	Salam mishri
Family: Linaceae		
Reinwardtia trigyna	S	Basant
Family: Loganiaceae		
Buddleia paniculata	S	Safed chindwa
Family: Loranthaceae		
Loranthus elatus	S	Banda, Pand
Loranthus vestitus	S	Banda, Pand
Viscum album	S	Bhangra
Family: Lythraceae		
Woodfordia floribunda	S	Dhan, Dawe
Family: Malvaceae		
Malva neglecta	H	
Family: Meliaceae		
Cedrela serrata	T	Darb, Krishing
Melia azedarach	T	Bakain, Drek
Family: Moraceae		
Ficus palmata	T	Phedu
Morus alba	T	Tut, Chimmu, Swa
Ficus foveolata	S	
Cannabis sativa	H	Bhang, Kus
Family: Morinaceae		
Morina longifolia	H	
Morina persica	H	
Family: Myrsinaceae		
Myrsine africana	S	Banwa, Chhota mehndru, Chitring
Family: Myrtaceae		
Eucalyptus globulus	T	Safeda
Family: Nyctaginaceae		
Oxybaphus himalaicus	H	

Family & Scientific name	Habit	Local name in Kinnaur Valley
Family: Oleaceae		
Fraxinus micrantha	T	Angu
Fraxinus xanthozyloides	T	Thum
Olea cuspidata	T	Kahu, Vee
Jasminum humile	S	Chameli, Kurang
Syringa emodi	S	
Jasminum dispermum	C	Malti
Jasminum officinale	C	Malti, Bammalti
Family: Orchidaceae		
Dactylorhiza hatagirea	H	
Epipactis veratrifolia	H	
Herminium monorchis	H	
Oreorchis indica	H	
Family: Papaveraceae		
Meconopsis aculeata	H	
Family: Phytolaccaceae		
Phytolacca acinosa	H	
Family: Pinaceae		
Abies pindrow	T	Tosh, Span
Abies spectabilis	T	Tosh, Span
Cedrus deodara	T	Deodar, Kelo, Diar, Kialmang
Larix himalaica	T	
Picea smithiana	T	Rai, Rayang
Pinus gerardiana	T	Neoza, Chilgoza
Pinus roxburghii	T	Chir
Pinus wallichiana	T	Kail, Lim
Family: Plantaginaceae		
Plantago tibetica	H	
Family: Poaceae		
Agropyron longearistatum	G	
Agropyron semicostatum	G	
Agrostis alba	G	
Agrostis royleana	G	
Andropogon ischaemum	G	
Arthraxon lanceolatus	G	
Arundinaria falcata	G	Ringal, Nirgal, Poo
Arundinaria spathiflora	G	Ringal, Nirgal, Poo
Arundinella brasiliensis	G	
Arundinella setosa	G	
Arundo donax	G	Nal, Naldura, Rajal
Avena aspera	G	
Avena fatua	G	
Bromus asper	G	
Bromus patulus	G	
Calamagrostis littorea	G	
Cynodon dactylon	G	Dub, Drub
Dactylis glomerata	G	

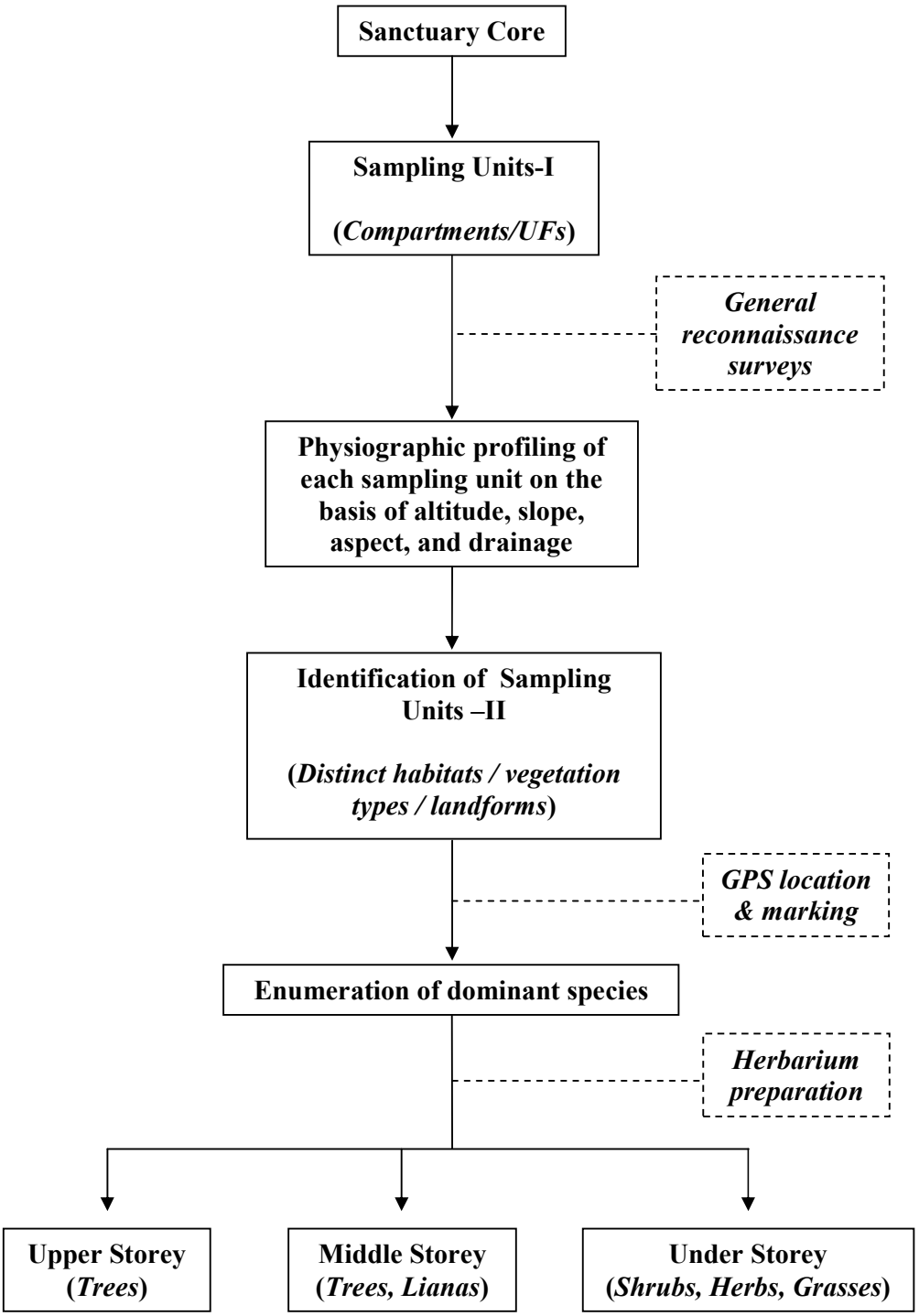
Family & Scientific name	Habit	Local name in Kinnaur Valley
Danthonia cachemyriana	G	
Deyeuxia scabrescens	G	
Eragrostis nigra	G	
Erianthus fulvus	G	Kahl
Erianthus ravennae	G	
Festuca gigantea	G	
Festuca kashmiriana	G	
Festuca modesta	G	
Ischaemum notatum	G	
Muehlenbergia himalayensis	G	
Neyraudia madagascariensis	G	
Oplismenus compositus	G	
Oryzopsis aequiglumis	G	
Panicum plicatum	G	
Paspalum ambiguum	G	
Pennisetum flaccidum	G	
Poa pratensis	G	
Pogonatherum saccharoideum	G	
Pollinia mollis	G	
Pollinia quadrinervis	G	
Setaria glauca	G	Siun
Setaria viridis	G	
Sporobolus piliferus	G	
Stipa sibirica	G	
Tripogon filiformis	G	
Family: Polemoniaceae		
Polemonium caeruleum	H	
Family: Polygonaceae		
Rheum australe	S	
Bistorta affinis	H	
Bistorta amplexicaulis	H	
Fagopyrum cymosum	H	
Persicaria polystachya	H	
Polygonum alatum	H	Malora
Polygonum polystachyum	H	
Polygonum rumicifolium	H	
Rumex acetosa	H	
Rumex hastatus	H	Malora, Bhilmora
Rumex nepalensis	H	Malora, Bhilmora
Family: Primulaceae		
Androsace lanuginosa	H	
Androsace rotundifolia	H	
Androsace sarmentosa	H	
Primula denticulata	H	Hantingoo
Primula involucrata	H	
Primula petiolaris	H	Kauri, Phantingoo
Family: Ranunculaceae		

Family & Scientific name	Habit	Local name in Kinnaur Valley
Clematis barbellata	C	Belkangu, Chabru, Wantah
Clematis connata	C	Garol, Wantah
Clematis grata	C	Garol, Wantah
Clematis montana	C	Garol, Wantah
Aconitum heterophyllum	H	Patish, Mohra
Anemone obtusiloba	H	Ageli
Anemone rivularis	H	Ageli, Carbini, Maruiri
Anemone tetrasepala	H	
Aquilegia pubiflora	H	
Caltha palustris	H	
Cimicifuga foetida	H	
Delphinium denudatum	H	Nirvisi
Delphinium vestitum	H	Kalulu
Ranunculus arvensis	H	
Ranunculus hirtellus	H	
Thalictrum javanicum	H	Garbin, Mamiri
Thalictrum neurocarpum	H	Barmot
Thalictrum pauciflorum	H	
Thalictrum pedunculatum	H	Garbin, Mamiri
Thalictrum platycarpum	H	
Family: Rhamnaceae		
Rhamnus virgatus	S	
Family: Rosaceae		
Prunus armeniaca	T	Chuli, Chul
Prunus cerasoides	T	Paja
Prunus cornuta	T	Jamun, Krun
Prunus persica	T	Baimi, Reg
Pyrus foliolosa	T	Ranreg
Pyrus lanata	T	Ban palti, Marpol
Pyrus pashia	T	Shagal, Batangi, Kainth, Lee
Cotoeaster microphylla	S	Raonsh
Cotoneaster acuminata	S	Chum raonsh, Banang
Cotoneaster bacillaris	S	Raonsh, Banang
Crataegus oxyacantha	S	Bat sangli
Principia utilis	S	Bhekal bekhlang
Rubus biflorus	S	Anchu
Rubus ellipticus	S	Hinsar, Kala chosho
Rubus lasiocarpus	S	Kalaksha, Swating
Rubus purpureus	S	
Spiraea bella	S	
Spiraea canescens	S	Takol, Chaku, Taku
Spiraea lindleyana	S	Kaltiri, Kueht
Rosa macrophylla	C	Pahari gulab, Kuja, Benyal
Rosa moschata	C	Kuja, Yal
Agrimonia eupatoria	H	Kanaula
Agrimonia pilosa	H	
Fragaria nubicola	H	Balbalsho

Family & Scientific name	Habit	Local name in Kinnaur Valley
Geum urbanum	H	Chandana
Potentilla argyrophylla	H	
Potentilla atrosanguinea	H	
Potentilla eriocarpa	H	
Potentilla nepalensis	H	Dora
Sibbaldia cuneata	H	
Family: Rubiaceae		
Leptodermis lanceolata	S	Choti frodari
Family: Rutaceae		
Skimmia laureola	S	Shashra, Kedar patti, Shuru
Zanthoxylum alatum	S	Timber, Tirmira, Timri
Boenninghausenia albiflora	H	Pesmmar
Family: Salicaceae		
Populus alba	T	Safeda, Mal
Populus ciliata	T	Pahari pipal, Chalun, Karamal, Mangal
Salix alba	T	Beuns
Salix babylonica	T	Majnun, Shon
Salix denticulata	T	Bhashal, Beuns, Shon
Salix calyculata	S	
Salix daphnoides	S	Buins, Bhainsala
Salix hastata	S	Buins
Family: Sapindaceae		
Acer acuminatum	T	Mander, Rikhandlu, Manderang
Acer caesium	T	Chirandru, Manderang
Acer oblongum	T	Parange, Manderang
Acer pictum	T	Mandlu, Mandar, Tian
Acer villosaum	T	Chirandru, Manderang
Aesculus indica	T	Jungli khanor, Poo
Family: Saxifragaceae		
Deutzia corymbosa	S	Philru, Chururu, Kakhu
Deutzia staminea	S	Ghugtai
Ribes grossularia	S	
Ribes orientale	S	
Bergenia ciliata	H	
Saxifraga brunonis	H	
Saxifraga diversifolia	H	
Family: Schisandraceae		
Schisandra grandiflora	C	Angeli
Family: Scrophulariaceae		
Digitalis purpurea	H	
Pedicularis bicornuta	H	
Pedicularis pectinata	H	
Pedicularis rhinanthoides	H	
Pedicularis siphonantha	H	
Picrorhiza kurrooa	H	Karu, Kardi, Karwi
Scrophularia decomposita	H	

Family & Scientific name	Habit	Local name in Kinnaur Valley
Scrophularia elatior	H	
Scrophularia himalensis	H	
Verbascum thapsus	H	
Veronica serpyllifolia	H	
Wulfenia amherstiana	H	
Family: Smilacaceae		
Smilax vaginata	S	Peepal satta
Smilax parvifolia	C	
Family: Solanaceae		
Solanum dulcamar	S	
Atropa belladonna	H	Saagngur
Datura stramontium	H	Datura
Hyoscyamus niger	H	
Family: Staphyleaceae		
Staphylea emodi	S	Nag daun
Family: Symplocaceae		
Symplocos crataegoides	T	Lodar, Logh
Family: Tamaricaceae		
Myricaria rosea	S	
Family: Taxaceae		
Taxus baccata	T	Rakhal, Barmi, Neyamdal
Family: Thymelaeaceae		
Daphne oleoides	S	Jiko
Daphne papyracea	S	Kaula, Gandiri
Daphne retusa	S	Agru
Wikstroemia canescens	S	Chambat, Tilak
Family: Tiliaceae		
Grewia oppositifolia	T	Beul, Dhaman, Beulang
Family: Ulmaceae		
Celtis australis	T	Khirak, Koo
Ulmus laevigata	T	Maral, Maldung
Ulmus wallichiana	T	Marn, Maldung
Family: Urticaceae		
Girardinia diversifolia	H	Bechu buti
Urtica dioica	H	
Family: Valerianaceae		
Valeriana hardwickii	H	Nihani, Nakh
Valeriana pyrolaefolia	H	
Valeriana wallichii	H	Mushkbala
Family: Violaceae		
Viola biflora	H	
Viola patrinii	H	Banafsha
Viola serpens	H	Banafsha
Family: Vitaceae		
Parthenocissus semocordata	C	Miaza
Vitis trifolia	C	Pola

Appendix 6. A schematic diagram showing the sampling protocol for vegetation sampling to develop beat/compartment-wise vegetation mapping.



Appendix 7. Description of vegetation composition of upper storey and undergrowth in each forest of core area of Rupi Bhaba Sanctuary (adopted from Pandey, 1991)

Range	Beat	Forest	Upper storey	Undergrowth	
				Shrubs	**Herbs**
Rupi	Shamno	UF-1	Kail, spruce, fir, bird-cherry, maple, walnut, hazelnut, kharsu, and *Taxus baccata*	*Cotoneaster bacillaris*, *Deutzia corymbosa*, *Indigofera* spp., *Viburnum* spp., *Spiraea canescens*, & *Lonicera angustifolia*	*Fragaria vesca*, *Viola serpens*, & *Salvia glutinosa*
Rupi	Shamno	UF-2	Grassy blank with kail, ban oak, & *Rhododendron arboreum*	*Spiraea canescens*, *Indigofera* spp., & *Rubus ellipticus*	*Viola serpens*, *Salvia glutinosa,* & *Fragaria* spp.
Rupi	Rupi	UF-3	Kharsu, kail, spruce, bird-cherry, hazelnut, & walnut	*Cotoneaster bacillaris*, *Deutzia corymbosa*, *Indigofera* spp., *Spiraea canescens*, & *Lonicera angustifolia*	*Fragaria* spp., *Viola serpens*, & *Salvia glutinosa*
Rupi	Rupi	UF-4	Spruce, kharsu, maple, bird-cherry, & walnut	*Desmodium* spp., *Indigofera* spp., *Rubus ellipticus, Cotoneaster bacillaris,* & *Viburnum* spp.	*Fragaria* spp. & *Viola serpens*
Rupi	Dabling	UF-5	Kail, kharsu, & spruce	*Desmodium* spp., *Indigofera* spp., *Rubus ellipticus,* & *Viburnum* spp.	*Fragaria* spp. & *Viola serpens*
Rupi	Shamno	UF-6	Deodar & kail	*Desmodium* spp., *Indigofera* spp., *Rubus ellipticus,* & *Viburnum* spp.	
Rupi	Shorang	UF-7	Kail (mixed with spruce), kharsu, horse chestnut, bird-cherry, walnut, & hazelnut	*Cotoneaster bacillaris*, *Deutzia corymbosa*, *Indigofera* spp., & *Viburnum* spp.	*Fragaria vesca*, *Viola serpens*, *Salvia glutinosa* & light grass growth
Rupi	Shorang	UF-8	Kail, spruce, horse chestnut, bird-cherry, maple, & walnut	*Cotoneaster bacillaris*, *Deutzia corymbosa*, *Indigofera* spp., *Viburnum*	*Fragaria vesca*, *Viola serpens*, *Salvia glutinosa* & light grass

Range	Beat	Forest	Upper storey	Undergrowth	
				Shrubs	**Herbs**
				spp. & ringal	growth
Rupi	Shorang	UF-9	Spruce, horse chestnut, bird-cherry, maple, and stunted kharsu	*Deutzia corymbosa*, *Viburnum* spp. & ringal	*Fragaria vesca* & *Salvia glutinosa*
Rupi	Shorang	UF-10	Kail, spruce, horse chestnut, bird-cherry, maple, & walnut	*Cotoneaster bacillaris, Viburnum* spp. & ringal	*Fragaria vesca*, *Salvia glutinosa, &* some grasses
Rupi	Bara Kamba	UF-11	Fir & spruce, kail, bird-cherry, horse-chestnut, maple, & walnut in depressions	*Cotoneaster bacillaris, Viburnum* spp. & ringal	
Rupi	Bara Kamba	UF-12	Predominantly fir & spruce; kail, bird-cherry, *Acer* spp., walnut, horse-chestnut in depressions	*Cotoneaster bacillaris, Viburnum* spp., *Skimmia laureola, Deutzia corymbosa* & ringal	*Strobilanthes* spp.
Rupi	Bara Kamba	UF-13	Predominantly fir & spruce; kail in patches; horse chestnut, *Acer* spp., walnut, and bird-cherry in depressions; kharsu on fringe	*Cotoneaster bacillaris, Viburnum* spp., *Skimmia laureola*, & *Deutzia corymbosa*	*Strobilanthes* spp
Rupi	Bara Kamba	UF-14	Predominantly kail; fir & spruce in pure patches; horse chestnut, walnut, bird-cherry, *Acer* spp. in nallas and moist interior depressions	*Cotoneaster bacillaris, Viburnum* spp., *Skimmia laureola,* & *Rhododendron campanulatum*	*Fragaria vesca*, *Viola serpens*, *Strobilanthes* spp & *Salvia glutinosa*
Rupi	Bara Kamba	UF-15	Predominantly kail mixed with deodar and spruce; kharsu higher up	*Indigofera* spp., *Cotoneaster bacillaris, Viburnum* spp., *Skimmia laureola, Desmodium* spp., & *Rosa moschata*	*Fragaria vesca*, *Viola serpens*, & some grass growth
Rupi	Chota Kamba	UF-16	Predominantly kharsu oak, & bird-cherry and walnut in depressions	*Desmodium tiliaefolium*, *Indigofera* spp., *Rubus ellipticus*, & *Rosa moschata*	
Rupi	Chota Kamba	UF-17	Predominantly kail in lower	*Rubus ellipticus*, *Rosa*	

Range	Beat	Forest	Upper storey	Undergrowth	
				Shrubs	**Herbs**
			portions; spruce, bird-cherry, & kharsu oak in depressions	*moschata, Indigofera* spp. & *Desmodium* spp.	
Katgaon	Katgaon	UF-27	Predominantly fir and spruce forest; kail on southern aspect; walnut, maple, & horse chestnut in depressions	*Cotoneaster bacillaris*, *Deutzia corymbosa*, *Indigofera* spp., *Viburnum* spp., *Spiraea* spp., *Skimmia laureola*, & *Lonicera angustifolia*	*Salvia glutinosa, Jurinea macrocephalla, Thalictrum* spp., *Gentiana kurroo,* & ferns and grasses
Katgaon	Yangpa	UF-28	Predominantly spruce and silver fir forest; kail on ridges; walnut, horse chestnut, hazelnut, & maple occur in depressions.	*Viburnum* spp., *Deutzia corymbosa*, *Lonicera angustifolia,* & *Desmodium tiliaefolium*	*Salvia glutinosa, Jurinea macrocephalla, Thalictrum* spp., *Fragaria vesca,* & ferns and grasses
Katgaon	Yangpa	UF-29	Predominantly spruce with mixture of fir on upper reaches and kail on warmer aspects; broadleaved birch and *Taxus baccata* on upper reaches; walnut, maple, horse chestnut, & hazelnut in depressions	*Viburnum* spp., *Deutzia corymbosa*, *Lonicera angustifolia, Desmodium tiliaefolium, Spiraea* spp., & *Skimmia laureola*	*Salvia glutinosa, Jurinea macrocephalla, Thalictrum* spp., *Fragaria vesca,* & ferns
Katgaon	Shango	UF-30	Predominantly kail forest replaced by spruce and silver fir on upper reaches; walnut, maple, horse chestnut, & hazelnut in cooler depressions	*Viburnum* spp., *Lonicera angustifolia, Desmodium tiliaefolium, Cotoneaster bacillaris*, & *Indigofera* spp.	*Salvia glutinosa, Jurinea macrocephalla, Fragaria vesca*, *Viola serpens, Gentiana kurroo,* & ferns and grasses
Katgaon	Shango	UF-31	Predominantly mid-aged kail forest with an admixture of silver fir and spruce in upper reaches and shady vales; broadleaved species like	*Viburnum* spp., *Deutzia corymbosa*, *Lonicera angustifolia, Desmodium tiliaefolium, Spiraea* spp., & *Indigofera* spp.	*Salvia glutinosa, Jurinea macrocephalla, Viola serpens, Gentiana kurroo,* & ferns and

Range	Beat	Forest	Upper storey	Undergrowth	
				Shrubs	**Herbs**
			walnut, maple, & bird-cherry in depressions		grasses
Katgaon	Kangarang	UF-32	Predominantly silver fir and spruce with an admixture of deodar along Listi Dogri; kail & spruce on warmer aspects; broadleaved species like walnut, maple, & bird-cherry in depressions	*Viburnum* spp., *Deutzia corymbosa*, *Cotoneaster bacillaris*, *Desmodium tiliaefolium*, & *Spiraea* spp.	*Salvia glutinosa, Viola serpens, Jurinea macrocephalla, Thalictrum* spp., *Gentiana kurroo,* & *Nepeta* spp.
Katgaon	Kangarang	C-87	Predominantly spruce with a few deodar and kail poles/stumps on rocky terrain below 2500m; pure deodar patches between 2100 and 2700m	*Viburnum* spp., *Deutzia corymbosa*, *Lonicera angustifolia, Desmodium tiliaefolium, Rosa* spp. & *Rubus* spp.	*Thalictrum* spp., *Salvia glutinosa, Fragaria vesca*, *Viola serpens, Impatiens* spp. & ferns
Katgaon	Kangarang	C-88	Above the inspection path from Yangpa to Thawach, the vegetation is mainly spruce and silver fir with broadleaved species and some kail on ridge tops; deodar stands and growing stock with a few kail poles	*Viburnum* spp., *Deutzia corymbosa*, *Skimmia laureola*, & *Lonicera angustifolia*	*Thalictrum* spp., *Salvia glutinosa, Fragaria vesca*, *Viola serpens, Impatiens* spp. & ferns
Katgaon	Kangarang	C-89	Predominantly spruce with some kail; broadleaved species like like walnut, maple, hazelnut & bird-cherry in cooler vales	*Spiraea lindleyana, Viburnum* spp., *Deutzia corymbosa*, *Lonicera angustifolia, Desmodium tiliaefolium,* & *Skimmia laureola*	*Salvia glutinosa, Ainsliaea aptera, Thalictrum* spp., & *Impatiens* spp.
Katgaon	Katgaon	C-90	Deodar, kail, & spruce	*Indigofera* spp., *Desmodium tiliaefolium, Lonicera angustifolia, Deutzia corymbosa* &	*Salvia glutinosa, Nepeta* spp., & *Thalictrum* spp.

Range	Beat	Forest	Upper storey	Undergrowth	
				Shrubs	**Herbs**
Katgaon	Katgaon	C-91	Spruce, kail, & deodar	*Spiraea lindleyana* *Indigofera* spp., *Desmodium tiliaefolium, Lonicera angustifolia, Viburnum* spp., & *Plectranthus rugosus*	*Salvia glutinosa, Nepeta* spp., *Thalictrum* spp., *Impatiens* spp. & ferns
Rupi	Chota Kamba	C-95	Kail and deodar	*Indigofera* spp. & *Viburnum* spp.	*Salvia glutinosa, Viola serpens, Fragaria vesca*, & grasses
Rupi	Chota Kamba	C-96	Kail and deodar	*Desmodium tiliaefolium, Indigofera* spp., Rubus spp., *Plectranthus rugosus*, & *Spiraea* spp.	*Salvia glutinosa, Fragaria vesca*, & ferns and grasses
Rupi	Shorang	C-97	Kail mixed with spruce and deodar; broadleaved species like horse chestnut, bird-cherry, and walnut occur in moist depressions	Ringal, *Deutzia corymbosa, Desmodium tiliaefolium, Cotoneaster bacillaris*, & *Viburnum* spp.	*Salvia glutinosa, Fragaria vesca*, & ferns and grasses
Rupi	Dabling	C-98	Predominantly mixed temperate broadleaved forest including horse chestnut, maple, bird-cherry, & walnut; a few mixture of kail, deodar, and silver fir	Ringal, *Desmodium* spp., *Viburnum* spp., & *Skimmia laureola*	*Salvia glutinosa, Fragaria vesca*, & ferns and grasses
Rupi	Dabling	C-99	Kail and deodar	*Desmodium tiliaefolium, Indigofera* spp., *Rubus ellipticus*, & *Plectranthus rugosus*	*Fragaria vesca*, *Viola serpens,* & light grass growth

Appendix 8. A provisional list of the birds of Rupi-Bhaba Wildlife Sanctuary. Species marked with * were not seen in the survey, though they possibly occur in the area. Species noted as '***Absent?***' were not seen or heard in the survey, and are presumed to be locally absent here as these species are normally very common and vocal in their range and it is hard to miss them if they occur.

Sl.No.	Common Name	Scientific Name	Notes
	Family: Phasianidae		
1	Snow Partridge	*Lerwa lerwa**	
2	Himalayan Snowcock	*Tetraogallus himalayensis*	
3	Chukar	*Alectoris chukar*	
4	Black Francolin	*Francolinus francolinus*	
5	Common Hill Partridge	*Arborophila torqueola*	Absent?
6	Western Tragopan	*Tragopan melanocephalus*	Endemic to WH & Vulnerable.
7	Koklass Pheasant	*Pucrasia macrolopha*	
8	Himalayan Monal	*Lophophorus impejanus*	
9	Kalij Pheasant	*Lophura leucomelanos*	
10	Cheer Pheasant	*Catreus wallichi*	Endemic to WH & Vulnerable.
	Family: Phalacrocoracidae		
11	Little Cormorant	*Phalacrocorax niger*	
	Family: Falconidae		
12	Common Kestrel	*Falco tinnunculus*	
13	Eurasian Hobby	*Falco subbuteo*	
14	Peregrine Falcon	*Falco peregrinus**	
	Family: Accipitridae		
15	Black-eared Kite	*Milvus lineatus*	
16	Lammergeier	*Gypaetus barbatus*	
17	Himalayan Griffon Vulture	*Gyps himalayensis*	
18	Hen Harrier	*Circus cyaneus*	
19	Besra	*Accipiter virgatus**	
20	Eurasian Sparrowhawk	*Accipiter nisus*	
21	Northern Goshawk	*Accipiter gentilis**	
22	Himalayan Buzzard	*Buteo burmanicus*	
23	Black Eagle	*Ictinaetus malayensis*	
24	Steppe Eagle	*Aquila nipalensis**	
25	Golden Eagle	*Aquila chrysaetos*	
26	Booted Eagle	*Hieraaetus pennatus*	
27	Mountain Hawk-eagle	*Spizaetus nipalensis**	
	Family: Ibidorhynchidae		
28	Ibisbill	*Ibidorhyncha struthersii**	
	Family: Scolopacidae		
29	Eurasian Woodcock	*Scolopax rusticola*	
30	Solitary Snipe	*Gallinago solitaria**	
31	Wood Snipe	*Gallinago nemoricola**	Vulnerable
	Family: Columbidae		
32	Rock Pigeon	*Columba livia*	
33	Snow Pigeon	*Columba leuconota*	

Sl.No.	Common Name	Scientific Name	Notes
34	Speckled Wood-pigeon	*Columba hodgsonii*	
35	Oriental Turtle-dove	*Streptopelia orientalis*	
36	Wedge-tailed Green-pigeon	*Treron sphenurus*	
	Family: Psittacidae		
37	Slaty-headed Parakeet	*Psittacula himalayana*	
	Family: Cuculidae		
38	Large Hawk-cuckoo	*Hierococcyx sparverioides*	Absent?
39	Common Cuckoo	*Cuculus canorus*	
40	Himalayan Cuckoo	*Cuculus saturatus*	
	Family: Strigidae		
41	Mountain Scops-owl	*Otus spilocephalus*	
42	Eurasian Eagle-owl	*Bubo bubo**	
43	Brown Wood-owl	*Strix leptogrammica**	
44	Himalayan Wood-owl	*Strix nivicola*	
45	Collared Owlet	*Glaucidium brodiei*	
46	Asian Barred Owlet	*Glaucidium cuculoides*	
	Family: Caprimulgidae		
47	Grey Nightjar	*Caprimulgus indicus jotaka*	
	Family: Apodidae		
48	Himalayan Swiftlet	*Collocalia brevirostris*	
49	White-throated Needletail	*Hirundapus caudacutus*	
50	Alpine Swift	*Tachymarptis melba**	
51	Common Swift	*Apus apus**	
52	Fork-tailed Swift	*Apus pacificus**	
	Family: Alcedinidae		
53	Crested Kingfisher	*Megaceryle lugubris*	Absent?
	Family: Upupidae		
54	Eurasian Hoopoe	*Upupa epops*	
	Family: Megalaimidae		
55	Great Barbet	*Megalaima virens*	
	Family: Picidae		
56	Speckled Piculet	*Picumnus innominatus**	
57	Brown-fronted Woodpecker	*Dendrocopos auriceps**	Endemic to Western Himalaya
58	Himalayan Woodpecker	*Dendrocopos himalayensis*	Endemic to Western Himalaya
59	Scaly-bellied Woodpecker	*Picus squamatus*	
	Family: Campephagidae		
60	Long-tailed Minivet	*Pericrocotus ethologus*	
	Family: Laniidae		
61	Long-tailed Shrike	*Lanius schach*	
62	Grey-backed Shrike	*Lanius tephronotus*	
	Family: Oriolidae		
63	Eurasian Golden Oriole	*Oriolus oriolus**	
	Family: Dicruridae		
64	Ashy Drongo	*Dicrurus leucophaeus*	
	Family: Rhipiduridae		
65	Yellow-bellied Fantail	*Rhipidura hypoxantha*	

Sl.No.	Common Name	Scientific Name	Notes
	Family: Corvidae		
66	Eurasian Jay	*Garrulus glandarius**	
67	Black-headed Jay	*Garrulus lanceolatus*	
68	Yellow-billed Blue Magpie	*Urocissa flavirostris*	
69	Red-billed Blue Magpie	*Urocissa erythrorhyncha*	
70	Spotted Nutcracker	*Nucifraga caryocatactes*	
71	Red-billed Chough	*Pyrrhocorax pyrrhocorax*	
72	Yellow-billed Chough	*Pyrrhocorax graculus**	
73	Large-billed Crow	*Corvus macrorhynchos*	
	Family: Paridae		
74	Spot-winged Tit	*Parus melanolophus*	
75	Great Tit	*Parus major*	
76	Green-backed Tit	*Parus monticolus*	
77	Black-lored Tit	*Parus xanthogenys*	
	Family: Hirundinidae		
78	Eurasian Crag-martin	*Hirundo rupestris*	
79	Asian House-martin	*Delichon dasypus*	
	Family: Aegithalidae		
80	Black-throated Tit	*Aegithalos concinnus*	
81	White-throated Tit	*Aegithalos niveogularis*	Endemic to Western Himalaya
	Family: Alaudidae		
82	Oriental Skylark	*Alauda gulgula**	
	Family: Cisticolidae		
83	Striated Prinia	*Prinia crinigera*	
	Family: Pycnonotidae		
84	Himalayan Bulbul	*Pycnonotus leucogenys*	
85	Red-vented Bulbul	*Pycnonotus cafer*	
86	Black Bulbul	*Hypsipetes leucocephalus*	
	Family: Sylviidae		
87	Chestnut-headed Tesia	*Tesia castaneocoronata*	
88	Brownish-flanked Bush-warbler	*Cettia fortipes*	
89	Grey-sided Bush-warbler	*Cettia brunnifrons*	
90	Spotted Bush-warbler	*Bradypterus thoracicus*	
91	Large-billed Reed-warbler	*Acrocephalus orinus**	Data deficient
92	Tickell's Leaf-warbler	*Phylloscopus affinis*	
93	Buff-barred Warbler	*Phylloscopus pulcher*	
94	Ashy-throated Warbler	*Phylloscopus maculipennis*	
95	Lemon-rumped Warbler	*Phylloscopus chloronotus*	
96	Hume's Warbler	*Phylloscopus humei*	
97	Greenish Warbler	*Phylloscopus trochiloides*	
98	Large-billed Leaf-warbler	*Phylloscopus*	

Sl.No.	Common Name	Scientific Name	Notes
		magnirostris	
99	Western Crowned Warbler	*Phylloscopus occipitalis*	
100	Blyth's Leaf-warbler	*Phylloscopus reguloides*	
101	Grey-hooded Warbler	*Phylloscopus xanthoschistos*	
102	Green-crowned Warbler	*Seicercus burkii*	
103	Whistler's Warbler	*Seicercus whistleri*	
	Family: Timaliidae		
104	Rusty-cheeked Scimitar-babbler	*Pomatorhinus erythrogenys*	
105	Scaly-breasted Wren-babbler	*Pnoepyga albiventer**	
106	White-throated Laughingthrush	*Garrulax albogularis*	Absent?
107	Striated Laughingthrush	*Garrulax striatus*	
108	Rufous-chinned Laughingthrush	*Garrulax rufogularis*	
109	Streaked Laughingthrush	*Garrulax lineatus*	
110	Variegated Laughingthrush	*Garrulax variegatus*	
111	Chestnut-crowned Laughingthrush	*Garrulax erythrocephalus**	
112	Red-billed Leiothrix	*Leiothrix lutea*	
113	White-browed Shrike-babbler	*Pteruthius flaviscapis**	
114	Green Shrike-babbler	*Pteruthius xanthochlorus**	
115	Chestnut-tailed Minla	*Minla strigula**	
116	White-browed Fulvetta	*Alcippe vinipectus**	
117	Rufous Sibia	*Heterophasia capistrata*	Absent?
118	Whiskered Yuhina	*Yuhina flavicollis*	
	Family: Zosteropidae		
119	Oriental White-eye	*Zosterops palpebrosus*	
	Family: Regulidae		
120	Goldcrest	*Regulus regulus**	
	Family: Troglodytidae		
121	Winter Wren	*Troglodytes troglodytes*	
	Family: Sittidae		
122	White-tailed Nuthatch	*Sitta himalayensis**	
123	White-cheeked Nuthatch	*Sitta leucopsis*	
	Family: Certhiidae		
124	Eurasian Treecreeper	*Certhia familiaris**	
125	Bar-tailed Treecreeper	*Certhia himalayana*	
	Family: Sturnidae		
126	Common Myna	*Acridotheres tristis*	
	Family: Turdidae		
127	Blue Whistling-thrush	*Myophonus caeruleus*	
128	Pied Thrush	*Zoothera wardii**	
129	Plain-backed Thrush	*Zoothera mollissima**	
130	Eurasian Scaly Thrush	*Zoothera dauma**	

Sl.No.	Common Name	Scientific Name	Notes
131	Long-billed Thrush	*Zoothera monticola*	
132	Tickell's Thrush	*Turdus unicolor**	
133	White-collared Blackbird	*Turdus albocinctus*	
134	Grey-winged Blackbird	*Turdus boulboul*	
135	Chestnut Thrush	*Turdus rubrocanus**	
136	Dark-throated Thrush	*Turdus ruficollis*	
137	Mistle Thrush	*Turdus viscivorus*	
138	White-browed Shortwing	*Brachypteryx montana**	
	Family: Muscicapidae		
139	White-tailed Rubythroat	*Luscinia pectoralis*	
140	Indian Blue Robin	*Luscinia brunnea*	
141	Orange-flanked Bush-robin	*Tarsiger cyanurus*	
142	Golden Bush-robin	*Tarsiger chrysaeus**	
143	White-browed Bush-robin	*Tarsiger indicus*	
144	Blue-capped Redstart	*Phoenicurus caeruleocephala*	
145	Blue-fronted Redstart	*Phoenicurus frontalis*	
146	White-bellied Redstart	*Hodgsonius phaenicuroides**	
147	Plumbeous Water-redstart	*Rhyacornis fuliginosa*	
148	White-capped Water-redstart	*Chaimarrornis leucocephalus*	
149	Grandala	*Grandala coelicolor**	
150	Little Forktail	*Enicurus scouleri*	
151	Spotted Forktail	*Enicurus maculatus*	
152	Common Stonechat	*Saxicola torquatus*	
153	Grey Bushchat	*Saxicola ferreus*	
154	Blue-capped Rock-thrush	*Monticola cinclorhynchus*	
155	Chestnut-bellied Rock-thrush	*Monticola rufiventris*	
156	Blue Rock-thrush	*Monticola solitarius*	
157	Dark-sided Flycatcher	*Muscicapa sibirica*	
158	Asian Brown Flycatcher	*Muscicapa dauurica*	
159	Rusty-tailed Flycatcher	*Muscicapa ruficauda*	
160	Rufous-gorgeted Flycatcher	*Ficedula strophiata**	
161	Little Pied Flycatcher	*Ficedula westermanni**	
162	Ultramarine Flycatcher	*Ficedula superciliaris*	
163	Slaty-blue Flycatcher	*Ficedula tricolor*	
164	Verditer Flycatcher	*Eumyias thalassinus*	
165	Rufous-bellied Niltava	*Niltava sundara*	
166	Grey-headed Canary-flycatcher	*Culicicapa ceylonensis*	
	Family: Cinclidae		
167	White-throated Dipper	*Cinclus cinclus**	
168	Brown Dipper	*Cinclus pallasii*	
	Family: Dicaeidae		
169	Fire-breasted Flowerpecker	*Dicaeum ignipectus**	
	Family: Nectariniidae		

Sl.No.	Common Name	Scientific Name	Notes
170	Gould's Sunbird	*Aethopyga gouldiae*	
	Family: Passeridae		
171	House Sparrow	*Passer domesticus*	
172	Russet Sparrow	*Passer rutilans*	
	Family: Prunellidae		
173	Altai Accentor	*Prunella himalayana**	
174	Rufous-breasted Accentor	*Prunella strophiata**	
	Family: Motacillidae		
175	White Wagtail	*Motacilla alba**	
176	Citrine Wagtail	*Motacilla citreola**	
177	Grey Wagtail	*Motacilla cinerea*	
178	Olive-backed Pipit	*Anthus hodgsoni*	
179	Rosy Pipit	*Anthus roseatus*	
180	Upland Pipit	*Anthus sylvanus**	
	Family: Fringillidae		
181	Eurasian Chaffinch	*Fringilla coelebs**	
182	Fire-fronted Serin	*Serinus pusillus*	
183	Yellow-breasted Greenfinch	*Carduelis spinoides*	
184	European Goldfinch	*Carduelis carduelis*	
185	Plain Mountain-finch	*Leucosticte nemoricola*	
186	Spectacled Finch	*Callacanthis burtoni*	Endemic to Western Himalaya
187	Dark-breasted Rosefinch	*Carpodacus nipalensis**	
188	Common Rosefinch	*Carpodacus erythrinus*	
189	Pink-browed Rosefinch	*Carpodacus rodochroa*	
190	White-browed Rosefinch	*Carpodacus thura**	
191	Red Crossbill	*Loxia curvirostra**	
192	Brown Bullfinch	*Pyrrhula nipalensis**	
193	Red-headed Bullfinch	*Pyrrhula erythrocephala*	
194	Black-and-yellow Grosbeak	*Mycerobas icterioides*	
195	Collared Grosbeak	*Mycerobas affinis**	
196	Spot-winged Grosbeak	*Mycerobas melanozanthos*	
197	White-winged Grosbeak	*Mycerobas carnipes**	
	Family: Emberizidae		
198	Crested Bunting	*Melophus lathami**	
199	Rock Bunting	*Emberiza cia*	
200	Chestnut-eared Bunting	*Emberiza fucata*	

Appendix 9. Encounter rates of Galliforms in different trails in Rupi-Bhaba Wildlife Sanctuary surveyed during April-May, 2008. Please note that these surveys were done with no spatial or temporal replications, and the encounter rates are therefore to be interpreted with caution.

Date	Valley	Survey Trail	Distance (km)	Altitude Range (m)	Encounter Rate (Number of individuals / km)							
					Himalayan Snowcock	Chukar Partridge	Black Francolin	Cheer Pheasant	Kaleej Pheasant	Koklass Pheasant	Himalayan Monal	Western Tragopan
24-Apr-08	Rupi	Rupi FRH to Gaukanda Dhar	3	2450 - 2875						1.00	2.67	
25-Apr-08	Rupi	Rupi FRH to Shāmno Dhar	4	2370 - 2900						0.25	0.25	
25-Apr-08	Rupi	Around Shāmno Dhar	2	2930 - 3035							5.00	
26-Apr-08	Rupi	Shāmno Camp to Taé Dhar	2.5	2900 - 3200						1.60	2.40	
27-Apr-08	Shorang	Rupi to Dumti (Shorang Valley)	13	2500 - 3070						0.08	0.31	0.08
28-Apr-08	Shorang	Dumti to Muglāng Aag Thatch along Kumrang	2	2700 - 3240							8.00	0.50
29-Apr-08	Shorang	Dumti to Deiya Thatch along Shorang	2.5	2700 - 3200							2.40	1.20
30-Apr-08	Shorang	Dumti to Chota Kamba	11	2300 - 2700						0.18		
3-May-08	Shorang	Chota Kamba to Shāl Thatch (Base of Yurang Dhar)	3	2100 - 3180						1.33	0.67	
4-May-08	Shorang	Shāl Thatch to Yurang Dhar	1.2	3200 - 3800	1.67	3.33				2.50	8.33	1.67
6-May-08	Shorang	Chota Kamba to Salaring FRH	5	1800 - 2130		1.20	0.60	0.40				
7-May-08	Salaring	Salaring FRH to Lankapuri Valley (Bāling Sow Camp)	4	1850 - 2450								
8-May-08	Salaring	Bāling Sow camp to Kimpo-Kyalā Dhar (Lankapuri)	2	2480 - 2635							0.50	1.00
9-May-08	Salaring	Bāling Sow camp to Tū Shāng dhar and Lankapuri Ridge	1.5	2550 - 2720						0.67	0.67	0.67
11-May-08	Salaring	Salaring village to Lower Phuphal Ghad Valley	1.8	1800 - 2225				1.11	0.56			
16-May-08	Bhaba	Katgaon to Mulling (Bhaba valley)	13	2430 - 3260							0.15	
17-May-08	Bhaba	Mulling to Déyā Glacier (Upper Bhaba)	4.5	3260 - 3500	1.33						0.67	
18-May-08	Bhaba	Mulling basecamp to Mulling birch forest	3	3263 - 3295	1.00						0.33	
19-May-08	Bhaba	Mulling basecamp to Kara Pasture (Upper Bhaba)	5	3260 - 3605							0.20	
22-May-08	L'grng	Katgaon to Listegarang basecamp	5	2344 - 3011		0.88				0.40	0.60	
23-May-08	L'grng	Listegarang camp (Khasyan) to Pandoshwar Meadows	2	3025 - 3423						1.00	2.50	

Appendix 10. A provisional list of the mammals of Rupi-Bhaba Wildlife Sanctuary. Evidences for occurrence of species marked with * were not recorded in the survey, though they possibly occur in the area.

Sl. No.	Common Name	Scientific Name	Notes
	ORDER: INSECTIVORA		
	Family: Soricidae		
1	Himalayan Water Shrew	*Chimarrogale himalayica**	
2	Hodgson's Brown-toothed Shrew	*Soriculus caudatus**	
3	Grey Musk Shrew	*Suncus murinus*	Seen in residential buildings in Chota Kamba & Kafnu
4	Etruscan Pygmy Shrew	*Suncus etruscus**	
5	Grey Woodland Shrew	*Crocidura attenuata**	
6	Horsfield's Shrew	*Crocidura horsfieldii**	A data-deficient species
	ORDER: CHIROPTERA		
	Family: Rhinolophidae		
7	Greater Horseshoe Bat	*Rhinolophus ferrumequinum**	
	Family: Hippoisideridae		
8	Great Himalayan Leaf-nosed Bat	*Hipposideros armiger**	Though the nearest range is Mussoorie, it may well occur here.
	Family: Vespertilionidae		
9	Hodgson's Bat	*Myotis formosus**	
10	Nepal Whiskered Bat	*Myotis muricola**	
11	Brown Long-eared Bat	*Plecotus auritus**	
12	Common Serotine	*Eptesicus serotinus**	
13	Hutton's Tube-nosed Bat	*Murina huttoni**	
14	Javan Pipistrelle	*Pipistrellus javanicus**	
15	Common Noctule	*Nyctalus noctula**	
16	Leisler's Bat	*Nyctalus leisleri**	
17	Mountain Noctule	*Nyctalus montanus**	
18	Eastern Barbastelle	*Barbastella leucomelas**	
	ORDER: PRIMATES		
	Family: Cercopithecidae		
19	Rhesus Macaque	*Macaca mulatta*	Seen around Chota Kamba and Salaring villages; a small troupe in Lower Phuphal Ghad.
20	Common Langur	*Semnopithecus entellus*	A large troupe in Upper Lankapuri Valley
	ORDER: CARNIVORA		
	Family: Felidae		
21	Common Leopard	*Panthera pardus*	Indirect evidences
22	Snow Leopard	*Uncia uncia*	Indirect evidences in Upper Bhaba valley
23	Jungle Cat	*Felis chaus**	Possibly in Rupi valley

Sl. No.	Common Name	Scientific Name	Notes
24	Leopard Cat	*Prionailurus bengalensis*	Indirect evidences
	Family: Viverridae		
25	Small Indian Civet	*Viverricula indica**	Along Sutlej valley?
26	Large Indian Civet	*Viverra zibetha**	Along Sutlej valley?
27	Himalayan Palm Civet	*Paguma larvata*	Indirect evidences
	Family: Herpestidae		
28	Common Indian Mongoose	*Herpestes edwardsii**	Along Sutlej valley?
	Family: Mustelidae		
29	Eurasian Otter	*Lutra lutra**	Along upstream Lankapuri/Phuphal ghad?
30	Small-clawed Otter	*Amblonyx cinereus**	Along upstream Lankapuri/Phuphal ghad?
31	Stone Marten	*Martes foina**	
32	Yellow-throated Marten	*Martes flavigula*	Several sight records in Rupi, Shorang, Salaring, and Listegarang valleys
33	Pale Weasel	*Mustela altaica**	
34	Himalayan Weasel	*Mustela sibirica*	Sighted at Yurang dhar
35	Yellow-bellied Weasel	*Mustela kathiah*	Reported by shepherds
	Family: Canidae		
36	Jackal	*Canis aureus*	Around Chota Kamba
37	Red Fox	*Vulpes vulpes*	Indirect evidences
	Family: Ursidae		
38	Himalayan Brown Bear	*Ursus arctos*	Indirect evidences
39	Asiatic Black Bear	*Ursus thibetanus*	Indirect evidences
	ORDER: ARTIODACTYLA		
	Family: Moschidae		
40	Himalayan Musk Deer	*Moschus chrysogaster*	Indirect evidences
	Family: Cervidae		
41	Barking Deer (Indian Muntjac)	*Muntiacus muntjak**	
	Family: Bovidae		
42	Goral	*Naemorhedus goral*	Sighted in Rupi and Salaring valleys
43	Himalayan Serow	*Naemorhedus thar*	Indirect evidences
44	Himalayan Tahr	*Hemitragus jemlahicus*	
45	Asiatic Ibex	*Capra ibex**	
46	Blue Sheep (Bharal)	*Pseudois nayaur*	Indirect evidences
	ORDER: RODENTIA		
	Family: Sciuridae		
47	Five-striped Palm Squirrel	*Funambulus pennantii*	Seen along Sutlej valley
48	Red Giant Flying Squirrel	*Petaurista petaurista*	Several foraging signs in oak forests in Rupi and Shorang valleys; one sight record in

Sl. No.	Common Name	Scientific Name	Notes
			Rupi.
49	Small Kashmir Flying Squirrel	*Hylopetes fimbriatus*	Indirect evidences in Lankapuri valley
50	Himalayan Marmot Family: Muridae	*Marmota himalayana**	
51	Stoliczka's Mountain Vole	*Alticola stoliczkanus**	
52	Royle's Mountain Vole	*Alticola roylei*	One dead specimen in Upper Bhaba Valley at 3400 m
53	Blyth's Vole	*Microtus leucurus**	
54	House Rat	*Rattus rattus*	In villages
55	Turkestan Rat	*Rattus turkestanicus**	
56	Chestnut Rat	*Niviventer fulvescens**	
57	White-bellied Rat	*Niviventer niviventer**	
58	Wood Mouse	*Apodemes sylvaticus**	
59	Miller's Wood Mouse	*Apodemes rusiges**	
60	House Mouse	*Mus musculus**	
61	Little Indian Field Mouse Family: Hystricidae	*Mus booduga**	
62	Indian Crested Porcupine	*Hystrix indica*	Indirect evidences
	ORDER: LAGOMORPHA Family: Leporidae		
63	Indian Hare Family: Ochotonidae	*Lepus nigricollis*	Indirect evidences
64	Royle' Pika	*Ochotona roylei*	Common in Yurang dhar and Upper Bhaba valley
65	Large-eared Pika	*Ochotona macrotis**	

Appendix 11. Occurrence and population status of important mammal species in different trails in Rupi-Bhaba Wildlife Sanctuary surveyed during April-May, 2008. The population status is expressed here as relative frequency of direct and indirect evidences encountered in our surveys [***: High, **: Medium, *: Low, and **?**: No evidence of presence though habitat seemed to be excellent]. Lack of spatial and temporal replicates means that these assessments may not accurately reflect true population density.

Valley	Survey Route	Altitude Range (m)	Common Langur	Him. Musk Deer	Himalayan Serow	Hinalayan Goral	Himalayan Tahr	Him. Black Bear	Brown Bear	Jackal	Red Fox	Leopard Cat	Common Leopard	Snow Leopard	Yellow-t. Marten	Himalayan Weasel	Giant Fly. Squirrel
Rupi	Rupi FRH to Gaukanda Dhar	2450 - 2875	*			**		*		?		*	**		*		***
Rupi	Rupi FRH to Shāmno Dhar	2370 - 2900								?		*	*		*		***
Rupi	Around Shāmno Dhar	2930 - 3035	*	**		**		**				*	***				**
Rupi	Shāmno Camp to Taé Dhar	2900 - 3200	**	**		*		**				*			*		***
Shorang	Rupi to Dumti (Shorang Valley)	2500 - 3070	**	**	***	*	*	**				**	***		*		*
Shorang	Dumti to Muglāng Aag Thatch along Kumrang	2700 - 3240		**	*	**	?	*			**	***	***				
Shorang	Dumti to Deiya Thatch along Shorang	2700 - 3200	**	**	*	**	***	**			*	**	**		*		
Shorang	Dumti to Chota Kamba	2300 - 2700	*	*	**	*		*				*	**		**		**
Shorang	Chota Kamba to Shāl Thatch (Base of Yurang Dhar)	2100 - 3180	*	**	*	***		**		**			***		**		*
Shorang	Shāl Thatch to Yurang Dhar	3200 - 3800					?		?		?				*	**	
Shorang	Chota Kamba to Salaring FRH	1800 - 2130	*					*		**		?	*		**		
Salaring	Salaring FRH to Lankapuri Valley (Bāling Sow Camp)	1850 - 2450	**	*	***	**	**	***		?			***		*		*
Salaring	Bāling Sow camp to Kimpo-Kyalā Dhar (Lankapuri)	2480 - 2635	***	***	***	***	**	***				**	***		**		?
Salaring	Bāling Sow camp to Tū Shāng dhar and Lankapuri Ridge	2550 - 2720	***	***	***	**	**	***				**	***		**		
Salaring	Salaring village to Lower Phuphal Ghad Valley	1800 - 2225	*	*	***	***		***		?		***	***				?
Bhaba	Katgaon to Mulling (Bhaba valley)	2430 - 3260		**		?	?	*				**	*				
Bhaba	Mulling to Déyā Glacier (Upper Bhaba)	3260 - 3500		***			?		**		**	*	?	**	**		
Bhaba	Mulling basecamp to Mulling birch forest	3263 - 3295		*					**		*			**	*		
Bhaba	Mulling basecamp to Kara Pasture (Upper Bhaba)	3260 - 3605					?		**		**			**	**	?	
L'garang	Katgaon to Listegarang basecamp	2344 - 3011	**	**		?	*	**		?	*	?	**				
L'garang	Listegarang camp (Khasyan) to Pandoshwar Meadows	3025 - 3423	***	**			**	**			*		***		?		

Appendix 12. A summary of management recommendations and initiatives suggested for different sites and beats in Rupi-Bhaba WLS.

Valley	Site/Range/Beat/Trek	FRH / Guest House	Staff quarters / Beat office	Field station / chowk / camp	Bunkers / Watch tower	Maintenance of trails/treks	Construction of bridges	Construction of pucca roads	Demarcation of boundaries	Checking of soil erosion	Vehicular support	Realignment of beats/ranges	Interpretation Centre	Habitat restoration	Control of poaching	Monitoring of forest fire	Reg. cattle grazing / NTFPs	Human-wildlife conflicts	Ecotourism initiatives	Dvpt of camping sites	Regulation of private resorts
Rupi	Rupi FRH/village		*					*	*		*						*	*	*		
Rupi	Rupi FRH to Gaukanda dhar				*	*													*	*	
Rupi	Rupi FRH to Shamno dhar			*	*	*			*					*					*	*	
Shorang	Dumti			*	*		*			*					*	*	*			*	
Shorang	Dumti to Muglāng Aag Thatch					*				*				*	*	*	*		*	*	
Shorang	Dumti to Deiya Thatch				*	*				*						*			*	*	
Shorang	Dumti to Chota Kamba along Shorang ghad					*	*												*	*	
Shorang	Shorang village		*	*					*		*	*					*		*	*	
Shorang	Chota Kamba village	*									*	*	*						*		
Shorang	Chota Kamba to Yurang dhar					*			*							*		*	*		
Shorang	Shal thatch / Yurang dhar			*	*										*		*		*	*	
Salaring	Salaring FRH/village								*		*	*		*		*		*			
Salaring	Salaring FRH to Lankapuri Valley			*	*	*	*		*						*		*				
Salaring	Salaring FRH to Phuphal Ghad Valley			*	*	*	*			*					*		*				
Bhaba	Katgaon/Kafnu village	*									*		*		*	*	*				*
Bhaba	Katgaon to Mulling Pasture			*	*	*		*	*	*					*		*	*	*	*	*
Bhaba	Mulling to Kara/Deiya alpine pastures				*	*									*		*				
L'garng	Shango village		*								*					*	*				
L'garng	Katgaon to Khasyan (Listegarang camp)			*	*	*			*						*	*	*	*	*	*	
L'garng	Listegarang camp to Pandoshwar meadows				*	*									*		*	*	*	*	

Appendix 13. Summary of research and training plans proposed to be undertaken in Rupi Bhaba WLS during 2010-15.

Sl. No.	Proposed Research/Training Plan	Time required	Approximate financial outlay	Agency / institution, recommended	Priority
1.	Mapping of vegetation types and landuse using GIS and RS tools	2 years	Rs. 25 lakh	WII, Dehradun & IIRS, Dehradun	High
2.	Training of field staff in wildlife population and habitat monitoring protocols	2 week capsule course/year	Rs. 6 lakh	WII, Dehradun	High
3.	Survey of mammals of the sanctuary with emphasis on distribution and population status	2 years	Rs. 10 lakh	WII, Dehradun, ZSI, and research NGOs	High
4.	Distribution mapping and ecology of Serow using GIS and Radio-telemetry approaches.	3 years	Rs. 40 lakh	WII, Dehradun, ZSI, and research NGOs	High
5.	Inventory of bats and their traditional roosting caves/sites	1 year	Rs. 5 lakh	ZSI	
6.	Genetic studies to ascertain taxonomic status of Common Langur populations that are found in high cliffs and ridges in Upper Lankapuri Valley	1 year	Rs. 10 lakh	NIAS & CES-IISc, Bangalore	
7.	Ecology of flying squirrels and their role in oak regeneration in temperate forests	3 years	Rs. 12 lakh	CES-IISc, Bangalore	
8.	Impacts of livestock grazing on pika populations in alpine areas	3 years	Rs. 15 lakh	GBPIHED, Almora	High
9.	Food habits of high-altitude mustelids with particular reference to their predation of small livestock	3 years	Rs. 6 lakh	WII, Dehradun	
10.	Survey of birds of the sanctuary with emphasis on distribution, movements, and population status	2 years	Rs. 6 lakh	WII, Dehradun and BNHS, Mumbai	High
11.	Population monitoring of galliforms (pheasants) in select trails using call counts and encounter rates	Long term	Rs. 2 lakh/ year	WII, Dehradun & WPA India	
12.	Ecology of Western Tragopan with emphasis on captive breeding and restocking of wild populations	Long term	Rs. 30 lakh	WII, Dehradun & WPA India	High
13.	Survey and monitoring of major nesting caves and cliffs of various species of montane swifts	3 years	Rs. 10 lakh	BNHS, Mumbai	
14.	Use of bird communities as indicators of ecosystem disturbance in temperate forests	3 years	Rs. 8 lakh	WII, Dehradun	

15.	Impacts of livestock grazing on bird communities of high-altitude alpine scrub	3 years	Rs. 8 lakh	NCF, Mysore	High
16.	Ecological study on sympatric warblers of Rupi-Bhaba Sanctuary	3 years	Rs. 6 lakh	WII, Dehradun	
17.	Role of birds in regeneration of oak-conifer forests with particular reference to nutcracker, grosbeaks, crossbill, and bullfinches of Rupi Bhaba Sanctuary	4 years	Rs. 7 lakh	WII, Dehradun	
18.	Inventory survey of herpetofauna of the sanctuary	2 years	Rs. 4 lakh	WII, Dehradun & ZSI	High
19.	Impacts of pesticides, water impoundments, habitat fragmentation, and roads on reptiles and amphibians of the sanctuary	4 years	Rs. 10 lakh	WII, Dehradun	
20.	Basic inventory of invertebrate biodiversity of the sanctuary	3 years	Rs. 8 lakh	ZSI, Dehradun	
21.	Identification of keystone and indicator taxa for ascertaining human-induced changes in habitats	5 years	Rs. 8 lakh	WII, Dehradun	High
22.	Weed ecology and management in the sanctuary vis-à-vis livestock grazing in wildlife habitats	4 years	Rs. 20 lakh	WII, Dehradun & GBPIHED, Almora	High
23.	Monitoring habitats for large mammals using habitat suitability models	4 years	Rs. 20 lakh	WII, Dehradun & IIRS, Dehradun	High
24.	Investigation and economic evaluation of ecosystem goods and services obtained from the sanctuary	4 years	Rs. 15 lakh	IIFM, Bhopal	High

Appendix 14. Tree plantation programme proposed for Rupi-Bhaba Wildlife Sactuary for the plan period of 2010-15.

Plan period	Plantation species	Plantation scheme	Area to be covered (ha)	Budget details			Forest beats to be covered
				Nursery cost (Rate/ha)	Cost of material supply	Total cost	
2010-11	Deodar & Spruce	PA plan	40 ha	Rs. 24,000/ha	Rs. 4,50,000	Rs. 14,10,000	Shamno, Homte, & Shango
	Fir & Spruce	Social forestry	30 ha	--do--	Rs. 4,20,000	Rs. 11,40,000	Rupi, Dabling, & Shorang
2011-12	Spruce & Fir	PA plan	40 ha	--do--	Rs. 4,50,000	Rs. 14,10,000	Katgaon & Kangarang
	Deodar	PA plan	20 ha	--do--	Rs. 3,75,000	Rs. 8,55,000	Shorang & Chota Kamba
2012-13	Kail & Walnut	Social forestry	30 ha	--do--	Rs. 4,00,000	Rs. 11,20,000	Rupi, & Shorang
	Fir & Spruce	PA plan	20 ha	--do--	Rs. 3,75,000	Rs. 8,55,000	Yangpa & Shango
2013-14	Fir & Spruce	PA plan	25 ha	--do--	Rs. 4,00,000	Rs. 10,00,000	Shamno & Upper Salaring
	Kail & Walnut	Social forestry	35 ha	--do--	Rs. 4,20,000	Rs. 12,60,000	Chota Kamba & Bara Kamba
2014-15	Deodar	Social forestry	20 ha	--do--	Rs. 3,75,000	Rs. 8,55,000	Shorang & Chota Kamba
	Spruce & Fir	Social forestry	25 ha	--do--	Rs. 4,00,000	Rs. 10,00,000	Katgaon

GNAPE

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Wildlife Wing
H.P. Forest Department