4.5.5 Faunal survey

Terrestrial Species

The animal species were observed and recorded at each of the four transects. Due to the time of ecological assessment and survey of the project catchment in winter and due to prevailing climatic conditions, including fresh snowfall and rainfall, many of the wild animals were not observed. The population sizes of the observed species were also low. Some of the higher reaches of the project catchment were inaccessible due to snow cover.

Animal presence was measured both through direct sightings and by indirect measures, such as quills, scats etc. All along the line transects visual observations were recorded for a distance of up to 200 m on both the sides of the line transect. Binoculars were used for recording details of distant animals.

4.5.6 Biodiversity Aspects of Flora and Fauna

Besides measuring these parameters, other biodiversity aspects in the form of endemic status, conservation status and life form have been enumerated. For all the species found in the area during ecological survey, Red Data Books of the Botanical Survey of India have been screened to verify their conservation status. For wild animal species, Schedule 1 of the Wildlife Preservation Act (1972) has been screened. ***Figure 4.10*** describes vegetation status within the state of Himachal Pradesh.

4.5.7 Aquatic Species

To ascertain aquatic diversity, mainly fishes, both the Allain and Duhangan streams within the project catchment area were surveyed. Different types of methods were used for surveying the streams for fishes. Trap nets, Dragnets, and Fist Traps were used. Three trap nets, 3 dragnets, and 3 fish traps were used. Trap nets and fish traps were laid in three locations simultaneously for a period of 5 hours, after which they were taken out and checked for any yield or fish catch. Dragnets were used for checking for fishes with special adaptations that remain attached to under surfaces of rocks to avoid fast stream flow. For each of the two streams, nets were fixed in six locations. Therefore, nets were fixed in a total of twelve locations. Similarly, Dragnets were also used at twelve locations. For each stream, survey locations started from area near the confluence of these streams with Beas and then moving upstream. Plate 1 shows the attempts for catching fishes in Allain and Duhangan streams.

4.5.8 Species Diversity – Flora and Fauna

Shannon Diversity Index has been used for estimating the diversity between the four-sampled Transects in order to highlight the most diverse Transect. The Shannon Diversity Index was calculated both for floral and faunal species. Diversity index is a unit of number of species and measures the effective number of species present in a sample. This effective number is expressed as the measure of the degree to which proportional abundance's are distributed among the species. Thus, Shannon index is a measure of the average degree of

uncertainty in predicting what species an individual chosen at random from a collection of 'S' species with 'N' individuals will belong.

4.5.9 Observations and Discussion - Overview of Forest Resources of Himachal Pradesh

The forests of the State have been classified on an ecological basis as laid down by Champion and Seth, and can be broadly classified into Coniferous Forests and broad-leaved Forests. Distribution of various species follows fairly regular altitudinal stratification. The vegetation varies from Dry Scrub Forests at lower altitudes to Alpine Pastures at higher altitudes. In between these two extremes, distinct vegetational zones of Mixed Deciduous Forests, Bamboo, Chir, Oaks, Deodar, Kail, Fir and Spruce, are found. The richness and diversity of flora of Himachal Pradesh can be gauged from the fact that, out of total 45,000 species found in the country as many as 3,295 species (7.32%) are reported in the State. About 150 species are exotics, introduced over the last 150 years.

Geographically, the total legally defined forest area of the state is 37,033 sq. km, of which about 13,083 sq km is under tree cover. Thus about 35.3% of the forest area is under tree cover. Dense forest (crown density >40%) in the state is about 9,120 sq km (16.38%). In district Kullu, out of the total geographic area of 5,503 sq km, legally classified forest area is 4,956 sq km. Of this, about 1,631 sq km is dense forest (crown density >40%).The forests of the state are a rich source of revenue and annually, as reported, about Rs 7,600 million are earned against an investment of Rs 360 million only.

4.5.10 General Description of the Project Catchment Area

The project falls in Himalayan Biogeographic Zone and specifically in the Biotic Province of the Northwest Himalayas. The altitude of the study area shows a wide variation and ranges from 1700 m (near Beas river) to 4800m (near Allain barrage) above the mean sea level. Characteristically, the area is a temperate zone, but based on variations in the altitude, sub temperate to alpine vegetation is found across the altitudinal gradient.

The project catchment area faces a strong and rather long winter from October to April. During the winter season, the higher reaches of the study area are always snow bound. Until end of March and sometimes up to the middle of April fresh snowfall is experienced in the area. December to February is the time for heavy snowfall and access to most of the proposed construction sites for barrages on both Allain and Duhangan remain inaccessible during this period of heavy snowfall.

Recorded rainfall for the project catchment for the years 1979 to 1994 indicate average rainfall of 1302.96 mm. The snowfall averages at about 343.26 mm annually. The entire project catchment is rich in water supply and water availability is adequate throughout the year. Flow rates are reduced during winter. The Allain, Duhangan and Pahali streams are perennial and drain into the Beas river.

On the basis of Primary Water Quality Criteria, it can be concluded that quality of Beas river falls under 'A' category of water with respect to pH, DO and BOD. The critical parameters observed is Total Coliform according to which category of river comes down to 'C' category in general in some stretches, which are close to towns. *Table 4.25* gives the water quality of Beas measured in Manali.

Table 4.25: River water quality measured at Manali U/S, 1001-R-BEAS

Month and Year	Parameter			
	PH	Dissolved Oxygen	Biochemical Oxygen Demand	Total Coliform
June 2001	8.16	9.8	0.1	17
September 2001	7.89	10.5	1.1	34
December 2001	7.53	11.6	0.5	350
March 2002	7.38	11.5	1.2	9

The mountain slopes show good to luxuriant forests. Most forests are pristine stands of spruce-fir associations, pure stands of deodar, mixed oak forests and blue pine forests. The slopes close to the Allain and Duhangan streams show good forest on the north facing slopes and a relatively rocky and less forested area on the south and southeast facing slopes.

4.5.11 Human Population in Project Catchment Area

As per census of 1991 there were a total of 3162 individuals in the three villages of Hamta, Prini and Jagatsukh falling in the project catchment. ***Figure 4.9 also shows the population count of the project area as well as of the adjoiniung areas in the State.*** Of**.** Of this population, about 34% are involved in agriculture and 18% in non-agricultural activities. Apple-orchard is the main agricultural activity. At the site for construction of the surgeshaft, there is no village and also there is no human habitation at the sites of barrage construction on both Allain and Duhangan.

4.5.12 Forest Types

Due to a high degree of altitudinal gradient, a number of forest types (based on revised Champion and Seth classification system) are found in the project catchment area. ***Figure 4.10*** shows the forest area in and around the project site. These are as follows:

- Western Mixed Coniferous Forests (12/C.1.d)
- Moist Temperate Deciduous Forests (12/C.1.e)
- Kharsu Oak Forests (12/C.2.a)
- Western Himalayan Upper Oak Forests (12/C.2.b)
- Himalayan Temperate Parklands (12/D.S.2)
- Himalayan Temperate Pastures (12/D.S.3)
- Western Himalayan Sub Alpine Fir Forests (14/C.1.a)
- Western Himalayan Sub Alpine Birch-Fir Forests (14/C.1.b)
- Sub Alpine Pastures (14/D.S.1)
- Birch-Rhododendron Scrub Forests (15/C.1)
- Dwarf Rhododendron Scrub (15/E.1)
- Dwarf Juniper Scrub (15/E.2)
- Alpine Pastures (15/C.3)

4.5.13 Forest Types at Project Catchment

During ecological survey, some of these forest types were found and sampled in the study area. Most high altitude forests and scrub forests could not be visited due to heavy snow. Although present, most broad-leaved forests are confined to lower altitudes and the project catchment is dominated by the presence of coniferous forests. Of the above-listed forest types, the following seven forest types were observed at the project catchment. Plate 3 shows some of the forest types found in the project catchment area.

1. Western Mixed Coniferous Forest (12/C.1.d) – This is the most common of all forest types found in the study area. It is wide spread and covers most of the slopes extending from the stream and going up to the mountaintops. During survey period, this forest type in the upper reaches of the study area was snow covered. These forest types have a varying mixture of coniferous trees of fine growth. The main constituents of this forest types are fir, spruce, silver fir, blue pine and deodar. Most trees attain a height of up to 50 m and the tree canopy is mostly dense. At few places an intermixing of broad-leaved trees was encountered. The forests also included patches of grassy meadows that contain some deciduous trees. Some of the species found in these forest type in the study area are *Abies pindrow, Pinus wallichinan, Cedrus deodara, Quercus semicarpifolia, Acer caesium, Deutzia corymbosa, Viburnum nervosum, Fragaria nubicola, Hedera nepalensis* etc.

2. Kharsu Oak Forests (12/C.2.a) – The oak, ranging from 10-20 m height is the chief constituent of this forest type in the study area. This forest is found to be mostly in patches, as an inclusion in the otherwise fir forests. Generally, groundcover is formed by deciduous shrubs and grasses. Some of the nearby associates of this forest types are blue pines, silver fir and occasionally spruce, although rarely in the study area.

3. Western Himalayan Upper Oak Forests (12/C.2.b) – It is also called as the oak-fir forest. It is a typically two-storied high forest with silver fir towering oak and other deciduous components. Shrubs are more or less present, although known to be pronounced during summer.

4. Himalayan Temperate Pastures (12/D.S.3) – These are found interspersed amongst temperate forests and provide excellent grazing grounds for high altitude wildlife, when it migrates to these areas during extreme winter. Their chief constituent species are grasses and herbs with certain bushy elements also present. *Danthonia, Primula, Rumex, Impatiens, Campanula* etc are mostly found in these pastures. These are observed close to the Western Mixed Coniferous Forests.

5. Western Himalayan Sub Alpine Fir Forests (14/C.1.a) – This is quite similar to the Western Mixed Coniferous Forests but is usually found on a higher elevation. As its name suggests, this forest type is typically dominated by *Abies pindrow* with some amount of tree species coming in from both the lower and higher altitudes. This forest type is found near the boundary of temperate and alpine zones.

6. Sub Alpine Pastures (14/D.S.1) – Typically open patches in between other forests, such as fir forests or sub alpine birch-fir forests, these are chiefly composed of grasses and other herbs. Some of the common grasses found in these forests include *Bromus, Dactylis, Festuca, Danthonia* etc. Herbs such as *Iris, Delphinium, Gentiana* etc are also found.

7. Alpine Pastures (15/C.3) – This forest type is found at higher altitudes. Typical herbaceous species are found here along with some *Rhododendron* species. Most plants here show good lateral growth instead of attaining height. This is an adaptation against snow and wind. Up on further increasing of the altitude these alpine pastures show Krumholtz vegetation types, which is an extreme adaptation to high velocity winds.

Figure 4.11 describes Forest Types within the Project Catchment Area. The location of these forest types in the study area is given below in *Table 4.26*.

Table 4.26: Forest Types Encountered in Project Catchment during Ecological Survey & Their Locations

S. No.	Forest Type	Code	Location
1	Western Mixed Coniferous Forest (See Plate 3)	12/C.1.d	Most widespread in the entire study area. Found on the north facing slopes of the Duhangan and Pahali stream and on the upper slopes of Hamta village. Also found on way to Hamta village and upstream of Allain.
2	Kharsu Oak Forest	12/C.2.a	Found on the south-facing slope on Duhangan. Only a small patch of this forest type was found. Also found in the south of the Pahali stream, close to the road itself.
3	Western Himalayan Upper Oak Forest	12/C.2.b	Found in the form of a patchy forest on the north facing slopes of the Allain stream.
4	Himalayan Temperate Pastures (See Plate 3)	12/D.S.3	Found at higher altitudes and near the site for Surge shaft. Also observed on the north facing slopes of Pahali stream.
5	Western Himalayan Sub Alpine Fir Forests (See Plate 3)	14/C.1.a	Found upstream of Duhangan before the sub alpine pastures. Present on both the sides of the stream.
6	Sub Alpine Pastures (See Plate 3)	14/D.S.1	Found in the form of thatch on upstream of Duhangan and near the confluence of Duhangan with Kala stream. Also found on the upper reaches of Hamta and near the Surge shaft site
7	Alpine Pastures (See Plate 3)	15/C.3	Found in upstream of Duhangan and Allain on way to barrage sites. Mostly restricted to above 3,800 m in altitude. Also seen at higher reaches beyond the Surge shaft site.