

Long Term Monitoring of Vegetation in
Great Himalayan National Park

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1.0 INTRODUCTION

Conservation of biological diversity while fulfilling the basic needs of local people through eco-development measures is the primary aim of Forestry Research Education and Extension project in Great Himalayan National Park (GHNP). In order to generate ecological information on various components of biodiversity and peoples' dependency which would aid in better conservation planning, WII has undertaken a multidisciplinary research project in this park. A part of this project (task # 5) deals with the floral inventory, quantification of important vegetation parameters and ethnobotany. One of the major objectives of this component is to collect the baseline information on various parameters of vegetation, including density and abundance of rare, endemic and valuable taxa of plants, from GHNP for subsequent monitoring.

Based on the floristic inventory made so far (Singh & Rawat, unpublished), we have confirmed the occurrence of 816 species belonging to 402 genera and 125 families and the breakup of these are given in the table below.

Distribution of species in various groups

Groups	Families	Genera	Species
Dicots	92	289	619
Gymnosperms	4	8	11
Monocots	16	89	159
Ferns	12	16	27
Total	125	402	816

Habit wise distribution of species

Groups	Trees	Shrubs	Climbers	Herbs	Grasses	Pterido-phytes	Total
Dicot	58	106	19	436	-	-	619
Gymno-sperm	8	3	-	-	-	-	11
Monocot	1	1	2	85	70	-	159
Pterido-phyta	-	-	-	-	-	27	27
Total	67	110	21	521	70	27	816



Preliminary ethnobotanical surveys reveal that more than 250 species of plants are used by local people in their day to day life. Nearly 60 plant species are harvested from the park area to earn their livelihood. As a result many species have become rare in the park. Detailed classification of plant communities for the park is in progress. However, for the general monitoring purpose we recommend Champion & Seth's (1968) categories of vegetation distributed in various altitudinal zones of GHNP. From the wildlife habitat point of view temperate and subalpine forests are of utmost importance as several threatened species such as western tragopan, monal, musk deer and serow have been observed to use these areas (Ramesh, K. and Vinod T.R. pers. comm.). Collection of morel mushroom (*Morchella esculenta*) for commercial purpose is one of the major income generating activities of the local people in GHNP. Our survey data reveals that this mushroom is found mainly between 2000 to 3000 m asl primarily in temperate coniferous and temperate broad leaved forests. Long term monitoring of above parameters in the presence or absence of anthropogenic pressures would be vital for detecting the impacts and sound management practices.

In this document we present the basic aims and methods of vegetation monitoring in GHNP. The key parameters of vegetation which could be easily monitored by the park staff after an initial field training details of suggested field sites for monitoring, type of data format used, seasonality and periodicity of data collection and baseline data are also given for various parameters.

2.0 AIMS

Vegetation forms an important component of the wildlife habitat (Gaston *et. al.* 1995). By looking at structure and composition of the vegetation one can assess the health of the local environment. Presence, absence or abundance of individual taxa can also indicate the ecological conditions or trends in an area (Gold Smith, F. B. 1991). Thus, a set of simple questions can be framed for the park staff in order to monitor the vegetation on the long term basis, e.g.,

- i. what is the proportion of lopped trees within each beat ? which species have been lopped ? has this proportion increased or decreased compared to one, two or three years before ?
- ii. what is the change in ground cover (%) in the given area after the removal of livestock? which species has increased and which species has declined?
- iii. How many seedlings of Rakhali/ Ban Oak / Dayar have grown into saplings and saplings into pole size crop since last time ? What difference it makes if the camping site or *Thach* is removed ?

- iv. What is the proportion of standing dead (snag) or fallen trees in the monitoring plot compared to zero year ? Which species have fallen ? What are the possible reasons ?
- v. What is the difference in the density and abundance of medicinal herbs in the given area between the previous and current year ? Which species are increasing in abundance with ban on collection and which species are not affected ?
- vi. What is the approximate amount (kgs) of mushroom collected by the villagers from each range ? whether the availability is increasing or decreasing compared to previous years ? What is the effect of rotational harvest of mushroom on the availability ? What is the effect of complete ban on mushroom collection within the monitoring plots ?

Similarly questions can also be framed on the use of area / vegetation type by different mammals and bird species based on indirect / direct evidences.

2.1 Methods of vegetation monitoring:

The methodology for recording above parameters of vegetation has been described below: The major survey routes have been marked on the map as well as in the field (Tirthan, Sainj, and Jiwanal area) including eco-development zone. Initially all the sectors in various habitats were marked systematically at an interval of 250 m along these trails. Details of various monitoring trails in Tirthan, Sainj and Jiwa valleys have been given in Table 1 and 2 respectively. The following baseline information have been collected from the marked plots:

- a. Circular plots of 12.61 m radius (500 m²): Trees including timber and fodder species their girth at breast height (GBH) and their regeneration, human pressure and wildlife use, structure and species composition.
- b. Nested plots of 5.65 m radius (100 m²): All the shrubs and saplings, their cover, height, browsing signs and other uses.
- c. Four square plots of 1m x 1m within each circular plot at north, west, south and east directions to record % cover of herbs and grasses, presence of medicinal plants, mushroom etc. General layout of the vegetation monitoring plot is shown in figure 1.

At each sampling plot altitude, aspect, slope, terrain type, vegetation type, wildlife and human use signs were be recorded on a fixed format (Appendix I,II & III).





Table 1: Details of various vegetation monitoring trails in Tirthan valley, GHNP

Tra. #	LOCATION/ DISTANCE COVERED	CLIMATIC ZONE	ALTITUDE (m)	# OF PLOTS	TREE SPECIES	REMARKS
T1	Devata to Supdhar (25 kms)	LT	1500-2000	22	44	Trail covers majority of forest types in the park and is good habitat for Goral, Himalayan Tahr and Musk Deer
		T	2000-2800	20		
		UT	2800-3300	15		
		SA	3300-3600	14		
		A	>3600	20		
T2	Rolla to Tirth (45 kms)	T	2000-2800	15	36	The trail is highly used by herb and 'Gucchi' collectors. Tirth is one of the best known botanical hot spots of the park where maximum herb collection is carried out.
		UT	2800-3300	24		
		SA	3300-3600	20		



T3	Rolla to Kholle Poe (10 kms)	T	2000-2800	18	10	The trail is important site for 'Gucchii' collection and is also good habitat of Goral.
		UT	2800-3300	11		
		SA	3300-3600	5		
T4	Nara to Koberi (8 kms)	SA	3300-3600	10	4	The trail is much used by the graziers and one of the disturbed site.
		A	>3600	12		
T5	Manoni to Gushani (25 kms)	LT	1500-2000	6	5	The trail is in high use for fuel wood and fodder collection.
		T	2000-2800	12		
		UT	2800-3300	13		
		SA	3300-3600	10		
		A	>3600	12		



T6	Chota-Basu to Silt (8 kms)	LT	1500-2000	4	17	The trail is visited for fuelwood and fodder collection.
		T	2000-2800	15		
		UT	2800-3300	4		
T7	Nara to Gumatroa (12 kms)	SA	3300-3600	18	6	This represents the habitat of Monal and Western Tragopan
		A	>3600	6		
T8	Gushani to Ropa (4)	LT	1500-2000	12	6	The area lies in Ecodevelopment area.
T9	Bathad to Khain	LT	1500-2000	15	15	The trail also lies in the Ecodevelopment area.
		T	2000-2800	20		



Table 2 : Details of vegetation monitoring trails suggested for Sainj and Jiwanal valleys.

Tra. #	LOCATION/DISTANCE	CLIMATIC ZONES	ALTITUDE	# OF PLOTS	TREE SPECIES	REMARKS
S1	Supdhar to Nevali (30 kms)	LT	1500-2000	15	38	The area is good habitat of black bear and brown bear. Dhela is frequently visited for medicinal herbs and graziers.
		T	2000-2800	20		
		UT	2800-3300	22		
		SA	3300-3600	15		
		A	>3600	18		
S2	Lapah to Sara thatch (10 kms)	LT	2000-2800	12	10	The trail is used by the 'Gucchii' collectors.
		T	2800-3300	15		
		SA	3300-3600	8		
S3	Shakti to Moror top (12 kms)	T	2000-2800	15	19	The trail passes through riverine vegetation
		SA	2800-3300	8		
S4	Lapah to Dhela (10 kms)	T	2000-2800	7	11	The trail is used by the graziers and herb collectors.
		UT	2800-3300	10		
		SA	3300-3600	8		
		A	>3600	10		



S5	Nevali to Sangard to Lapah (16 kms)	LT	1500-2000	15	15	This area lies in the Ecodevelopment zone.
		T	2000-2800	20		
S6	Nevali to Saran (8 kms)	LT	1500-2000	15	11	This trail also lies in the Ecodevelopment area.
		T	2000-2800	10		
J1	Seuyand to Majhan (20 kms)	LT	1500-2000	6	15	The transects is used for grazing of livestock animals and collection of fuelwood and fodder.
		T	2000-2800	18		
		UT	2800-3300	25		



3.0 Monitoring protocols and baseline data

The following section deals with the monitoring protocols and baseline information on various vegetation parameters. Various methods suggested for monitoring, the location, number of plots, season of monitoring and frequency of monitoring various parameters of vegetation are given in table 3.

Table 3.0: Vegetation parameters, methods of data collection and summary of monitoring protocols

VEGETATION COMPONENT	PARAMETER	METHOD	# OF PLOTS	SEASON	FREQUENCY
High altitude Medicinal plant	Species abundance, No. of herb collectors visiting the area	Regular plots and belt transects at fixed points	365	Sept-Oct	Yearly
Low altitude medicinal plants	Species abundance, No. of herb collectors visiting the area	Same as above	80	May-June	Yearly
Mushroom	Species abundance, Number of collector in various areas	Permanent monitoring plots of 20 X 20 m plots in the specified area and counting the number of collectors and quantity of collection at various check posts	14	March-April	Yearly
Tree species	Species, Population structure (Girth class distribution ratio of seedling, sapling and adult trees)	Systematic recording of gbh (Girth at breast height) of all species within the sampling plot	50	March-June	Once in five year

The trees and the shrubs are important components of vegetation and characterise the wildlife habitat. These species can be monitored on the various trails in every 10 years to see the change in the richness. Baseline data on this aspect in various ecological zones is given in the following table 3.1.

Table 3.1

VEGETATION TYPE	ALTITUDE	# OF PLOTS	# OF TREE SPECIES	# OF SHRUB SPECIES
TIRTHAN VALLEY (T1-T9)				
Lower Temperate	1500-2000	59	21	24
Temperate	2000-2800	100	22	19
Upper Temperate	2800-3300	67	11	18
Sub Alpine	3300-3600	77	5	12
Alpine	>3600	81	-	4
SAINJ VALLEY (S1-S6)				
Lower Temperate	1500-2000	36	18	20
Temperate	2000-2800	87	16	20
Upper Temperate	2800-3300	72	12	12
Sub Alpine	3300-3600	39	3	10
Alpine	>3600	18	-	3
JIWANAL VALLEY				
Lower Temperate	1500-2000	6	8	8
Tempearte	2000-2800	18	10	10
Upper Temperate	2800-3300	25	11	12

3.2 Monitoring population structure of tree species

Monitoring density, frequency, abundance, or even diversity gives some idea of change in the vegetation structure over a period of time but population structure is an easier parameter for monitoring vegetation and gives an idea of the growth of the forest. This parameter can be monitored in every 5 years and the growth of forest can be determined based on it. The sampling can be on the trail which has been marked earlier in each valley. Baseline data for 5 important species is given in table 3.2



Table 3.2 : Baseline data on the population structure of major tree species

VALLEY	SPECIES ABUNDANCE IN VARIOUS MONITORING ROUTES										
TIRTHAN		Rakhal		Ban oak		Kail		Dayar		Kharsu	
		T3	T2	T1	T6	T1	T8	T1	T8	T1	T7
	Seedling	-	-	3	2	4	4	3	-	-	-
	Saplings	1	-	2	3	10	6	2	3	3	1
	10-30	2	3	1	-	-	1	2	1	-	6
	31-60	6	5	-	2	8	5	2	5	12	5
	61-90	8	9	-	4	9	2	6	2	14	4
	91-120	10	15	3	3	8	4	5	2	16	2
	121-150	2	6	4	-	7	-	4	1	9	1
	151-180	4	8	1	-	3	2	-	1	3	3
	>180	1	4	4	4	3	5	1	4	4	2
	Snags	3	2	-	-	5	2	6	-	4	3
SAINJ	gbh	S1	S6	S4	S5	S4	S1	S1	S3	S4	S5
	Seedling	3	-	5	4	10	5	3	3	14	4
	Saplings	2	-	8	-	8	6	10	1	20	6
	10-30	-	1	-	3	-	4	1	2	2	1
	30-60	4	1	-	2	4	1	6	3	16	3
	61-90	6	2	5	3	1	5	2	5	24	-
	91-120	8	2	2	3	3	3	2	-	23	-
	121-150	15	1	2	1	3	8	4	6	23	2
	151-180	1	2	3	-	4	6	1	1	8	1
	>180	3	2	-	3	2	5	1	4	4	1
	Snags	-	8	-	2	10	6	3	-	5	-

3.2 Monitoring bamboo

The two species of bamboo found in GHNP are *Arundinaria falcata* locally known as Gari and *Thamnocalamus spathiflora* Ringal. Both the species are important for monitoring point of view as they form the habitat of endangered western tragopan, monal and various other birds. The leaves are preferred by goral and the young shoots are eaten by rhesus macaque, black bear and common langur. Local people use the culms for making baskets Kilta and also as walking stick. The women of the area collect the green twigs and leaves mainly during the winter months to feed the cattle, sheep and goats. The graziers carry the dried culms to the alpine pastures for the fuelwood and torchwood. The baseline data on the bamboo is given in the table 3.3. The species can be monitored once in 2 years in these sites within a circular plot of 5.65 m radius. The following parameters are recommended for future monitoring: number of cut culms, number of browsed twigs, number of new shoots, phenology, number of collectors and the quantity of bamboo collected from monitoring area.

Table 3.3 : Monitoring sites for *Arundinaria* spp. in various transects

Transect	<i>Arundinaria falcata</i>			<i>Arundinaria spathiflora</i>		
	Site	# of plots	# of culms	Site	# of plots	# of culms
T 1	Ropa-Rolla	7	262	Chordawar	9	193
T2	-	-	-	Chalocha	4	50
T3	-	-	-	Basu	4	65
T5	Nahi	2	36	Mononi	1	15
T7	-	-	-	Nara-Gumatroa	5	255
T8	Devta	3	54	-	-	-
T9	Above Mashiyar	1	12	-	-	-
S1	Nevali-Bah	4	75	Opposit Sakati	7	127
S2	Sara	2	38	-	-	-
S3	-	-	-	Maror	3	48
S5	Sangard	1	10	-	-	-
J1	Jiwa	4	147	-	-	-

3.3 Monitoring of medicinal plants

More than 250 ethnobotanically important plant species have been identified from the park (Singh unpublished). Of these 60 species are of medicinal value and some of them are even exported at commercial scale causing a serious threat to the existence. Some of these species have already been listed in Red Data Book of Indian plants. These species if needed can be monitored in near future. The suggested localities for monitoring are marked in figure 2.

Table 3.4 Critically endangered

A total of 25 species of Red data book were recorded from the park these species were studied through vegetation sampling. A total of 550 plots of 1 m² were laid in various stratified areas of alpine in the Tirth of Tirthan valley during September and October and data was analyzed for abundance, frequency and density. For studying the temperate species a total of 300 plots of 1 m² were laid in various monitoring trails and the data was analyzed following the same method as used for the alpine species.

SPECIES	LOCAL NAME	FAMILY	H	E	ABU	FRE	DENSITY/ha
<i>Aconitum balfourii</i>	PATISH	Ranunculaceae	A	C	1.00	0.36	9.09 ± 4.2
<i>Aconitum heterophyllum</i>	KARU.PATISH	Ranunculaceae	A	C	3.42	2.00	599.99 ± 13.45
<i>Aconitum violaceum</i>	MITH.PATISH	Ranunculaceae	A	C	22.26	5.45	7929.26 ± 221.42
<i>Angelica glauca</i>	CHORA	Apiaceae	T	C	2.81	14.00	350.00 ± 14.36
<i>Arnebia benthamii</i>	RATAN.JOT	Boraginaceae	A	C	4.15	0.55	163.63 ± 72.22
<i>Dactylorhiza hatagirea</i>	HATH.PANJA	Orchidaceae	A	C	2.00	3.45	945.45 ± 34.58
<i>Dioscorea deltoidea</i>	SINGLEE MUJALEE	Dioscoreaceae	T	C	1.88	6.00	1600 ± 264.35
<i>Fritillaria roylei</i>	FRITTLARI	Liliaceae	A	N C	1.00	0.55	309.09 ± 42.42
<i>Gentiana kurrooa</i>	KUTAKI	Gentianaceae	T-A	N C	*	*	*
<i>Meconopsis aculeata</i>	POPY	Paperveraceae	A	N C	2.00	2.55	763.63 ± 24.45
<i>Nardostachys jatamonsii</i>	NAHRU	Valerianaceae	A	C	1.00	0.18	18.18 ± 4.5
<i>Podophyllum hexandrum</i>	BAN.KAKARI	Berberidaceae	T-A	C	1.62	2.18	509.09 ± 33.33

<i>Berberis aristata</i>	MASHOLI	Berberidaceae	T	NC	100	15	3980.00 ± 651.42
<i>Berberis lycium</i>	MASHOLI	Berberidaceae	T	NC	100	22	4230.00 ± 364.42
<i>Bunium persicum</i>	KALA ZEERA	Apiaceae	T	NC	*	*	*
<i>Picrorhiza kurroa</i>	KARU	Scrophulariaceae	A	C	15.50	1.82	1963.63 ± 644.44
<i>Polygonatum verticillatum</i>	SALAM MISHRI	Liliaceae	T	C	5.41	0.73	290.90 ± 24.35
<i>Saussurea gossypiphora</i>	GHUGHU	Asteraceae	A	C	5.33	0.91	545.45 ± 24.12
<i>Saussurea obvallata</i>	BRAHMA KAMAL	Asteraceae	A	NC	3.50	0.367	127.26 ± 56.42

Endangered

<i>Berberis chitria</i>	MASHOLI	Berberidaceae	T	NC	5.00	12	3530.00 ± 351.45
<i>Berginia ligulata</i>	SABALA	Saxifragaceae	T	C	1.00	0.73	181.81 ± 45.15
<i>Hedychium spicatum</i>	SHEJULA	Zingiberaceae	T	C	6.12	6.00	2600.00 ± 140.45
<i>Rheum australe</i>	CHUKHRI	Polygonaceae	T-A	C	2.00	1.64	345.45 ± 24.05
<i>Thalictrum foliolosum</i>	GOLPATI	Ranunculaceae	T	NC	16.50	8.00	3400.00 ± 314.20

Low Risk

<i>Jurinea dolomiae</i>	DHOOP	Asteraceae	A	C	8.85	13.45	7999.99 ± 442.21
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Vulnerable

H= Habitat, E= Exploitation, ABU= Abundance, FRE= Frequency, C=Commercial, NC=Non-commercial, T=Temperate, A=Alpine * didn't occur in sampling plot

3.3.1 Monitoring of important medicinal plants

Medicinal plants are means of secondary income for the people living in and around GHNP. A large quantity of various medicinal plants have been commercially exploited in the recent past, since early sixties, and presently is at an alarming rate. Due to its abusive extraction, which were once believed ecologically sound practice. So a great need for monitoring these plants and their habitats was felt. Various species were identified for monitoring after extensive field study and their importance for the local people.

a) Species occurring > 3,300 m

The baseline information on habitat parameter of these sites have been suggested in the table below for future monitoring.

MONITORING SITES	HABITAT PARAMETERS				
	PLOTS	ALTITUDE	ASPECT	SLOPE	HABITAT TYPE
Bheemdawari	10	3700-3900	E, SW	10-65	Grazing area
Bheemdawari-Chandana	30	3800-4000	N, SW	20-50	Rocky cliff
Bheemdawari-Saketi	30	3825-4430	N, SW	25-65	Riverine
Devbhlee thach	15	3900-4200	W	60-75	Eroded land
Devbundi thach	15	3800-4000	E	20-60	Grazing area
Dhela	50	3400-3700	E	15-65	Grazing area
Dhela-Sakati	15	3400-3200	E	20-50	Camping site
Ganesh thach	15	3800-4000	E	30-55	Plateau
Gumatroa	15	3450-3550	E	20-40	Grazing area
Gumatroa camping site	15	3430	SE	15	Camping site
Gumatroa-Rikundi	20	3600-3900	SE	0-45	Exposed area
Koberi	15	3900-4200	SE	25-85	Bouldery area
Majhoni	20	3350-3450	SE	10-40	Grazing area
Nada	20	3300-3400	SE	15-25	Grazing and Camping
Nada-Gumatroa	10	3500-3600	SW	25-55	Grazing route
Nada-Koberi	15	3600-3800	S	35-80	Rocky
Rikhundi	10	3850-3900	Top	0	Bouldery
Saketi	10	4200-4400	W	15-25	Moraine
Thartadhar	10	3900-4100	SE	15-30	Bouldery
Tirth lake	10	3850-3900	W	5-15	Undisturbed area
Tirth thach	15	3700-3800	S	5-35	Grazing area

Table 6 : Monitoring sites for various medicinal herbs

Monitoring abundance of medicinal species in various sites

Various monitoring sites were and the number of plots in an area in which single species occurs and their number of individuals can easily be monitored on every year in the month of



September and October in these sites taking the random sampling plots in these areas.

MONITORING SPECIES									
<i>Aconitum heterophyllum</i>		<i>Aconitum violaceum</i>		<i>Dactylorhiza hatagirea</i>		<i>Jurinea dolomiaea</i>		<i>Picrorhiza kurrooa</i>	
Oc	n	Oc	n	Oc	n	Oc	n	Oc	pl
1	2	2	6	1	1	3	10	1	4
2	10	2	17	1	1	6	14	1	10
-	-	4	20	-	-	5	9	-	-
1	1	3	26	-	-	5	15	-	-
1	2	1	11	-	-	1	1	-	-
-	-	-	-	3	7	8	36	-	-
-	-	-	-	-	-	2	8	3	14
1	2	1	4	3	3	2	2	-	-
-	-	-	-	2	2	3	8	-	-
-	-	-	-	-	-	2	3	-	-
-	-	-	-	2	5	6	23	-	-
-	-	2	25	1	4	2	16	-	-
1	2	-	-	1	2	-	-	-	-
-	-	-	-	-	-	3	14	-	-
-	-	-	-	-	-	-	-	3	14
-	-	-	-	-	-	-	-	1	2
1	1	1	15	2	2	2	3	-	-
2	2	5	276	-	-	1	2	3	45
1	5	2	9	1	2	2	17	-	-
1	1	5	23	6	8	2	17	3	35
1	5	-	-	6	22	4	20	-	-

Table 7

Oc=Occurrence, n=Number of individuals

b) Species occurring < 3,300 M

The following habitat parameter can be monitored

Table 8

MONITORING SITES	HABITAT PARAMETERS				
	PLOTS	ALTITUDE	ASPECT	SLOPE	VEGETATION TYPE
Rolla (Tirthan valley)	10	2200-2300	W	15-25	Valley bottom
Shilt (Tirthan valley)	10	2900-3000	S	25-75	Coniferous
Kholeepoe (Tirthan valley)	10	2800-2900	N	20-45	Coniferous
Homkani (Sainj valley)	10	2500-2600	NW	15-35	Coniferous
Sakati (Sainj valley)	15	2300-2450	W	15-40	Broad leaved
Sara (Sainj valley)	15	2650-2700	SW	10-40	Coniferous
Mononi (Tirthan valley)	10	2900-3000	W	15-55	Coniferous

3.3.2 Monitoring abundance of the species

The Occurrence of the species and the number individuals species can be monitored every year in the month of May in these monitoring sites.

MONITORING SITES	ABUNDANCE OF THE MONITORING SPECIES									
	<i>Angelica gluca</i>		<i>Dioscorea deltoidea</i>		<i>Hypericum patalum</i>		<i>Valeriana jatamansi</i>		<i>Viola sp</i>	
	Oc	n	Oc	n	Oc	n	O c	n	Oc	n
Rolla (Tirthan valley)	2	5	5	12	1	3	-	5	8	64
Shilt (Tirthan valley)	-	-	-	-	-	-	5	16	6	24
Kholeepoe (Tirthan valley)	1	1	2	3	-	-	6	25	4	9
Homkani (Sainj valley)	3	5	5	8	-	-	6	11	3	10
Sakati (Sainj valley)	-	-	2	6	-	-	1	1	4	6
Sara (Sainj valley)	1	1	-	-	-	-	6	10	6	22
Mononi (Tirthan valley)	-	-	-	-	-	-	3	5	2	2

Table 9

Oc=Occurrence, n=No. of individuals

Monitoring of medicinal herbs collectors at the check post of Tirthan valley during 1996-97

The following parameters can be monitored in the all the checkpoints entrance by the forest guards and watchers on duty.

Month	No. of herb collectors	Village (no. Of herb collectors)	Name and quantity extracted	Area visited for collection.
Sep.1995	4	Dingcha 2, Kongcha 1, Sangcha 1	dhupe 90kg, karu 20kg	Tirth
Oct.1995	14	Dingcha 5, Tinder 1, Barnagi 1, Salinga 1, Gushani 3, Talinga 3	jangli haldi 160kg, dhupe 35kg	Tirth, Rally Kharudhar
Nov.1995	28	Dingcha 10, Talinga 5, Tinder 4, Sungcha 4, Plach 3, Sangchai 2	dhupe 140kg, jangli haldi 40kg	Tirth, Kharudhar
Jan.1996	-	-	-	-
Feb.1996	-	-	-	-
Mar.1996	39	Talinga 3, Manhara Salinga 4, Nanihar 3, Konucha 15, Nahe 4, Ladecha 1, Dingcha 9	gucchi 12kg	Basu, Rikhundi, Kharudhar, Chalocha, Barabasu, Koilipoi
Apr.1996	99	Salinga 8, Tinder 35, Sungcha 2, Konucha 55, Nahe 9, Ghadara 21, Dingcha 18	gucchi 80kg	Rikhundi, Koilipoi, Basu, Shilt, Kharudhar, Rally, Ladekhol
May.1996	62	Tinder 18, Salinga 2, Nahe 2, Konucha 25, Ghade 2, Manihar 2, Ropa 1, Dingcha 4, Tilnga 6	gucchi 20kg	Koilipoi, Barabasu, Rally, Chalocha, Kkharudhar, Ladi
Jun.1996	40	Manara 8, Konucha 2, Tinder 13, Fardi 1, Manane 2, Dingcha 10, Sungcha 4	dhupe 1000kg, roki 380kg	Tirth
Jul.1996	36	Dingcha 8, Tinder 10, Sungcha 8, Manine 2, Kouncha 3, Kharungcha 2, talinga 3	karoo 460kg, mahandhi 300kg, dhupe 500 kg, nahru 40kg	Rikhundi, Tirth, Koilipoi, Kobri, Nara
Aug.1996	12	Dingcha 2, Thbry 1, Tinder 2, Maruni 1, Nehi 1, Ghat 1, Ropa 4	dhupe 330kg, karu 150kg	Tirth, Nara, Kobri
Sep.1996	28	Tinder 1, Suncha 13, Dincha 2, Nogort 1, Ropa 2, Nehe 9, Dharn 2	dhupe 80kg, karu 330kg, mahandhi 80kg, patish 20kg	Kobri, Tirth

Table 10

Source: Checkpost Kharonacha, Tirthan valley

Monitoring of medicinal herbs collectors at the check post of Jiwanal valley during 1996-97

MONTHS	TOTAL	HERB COLLECTORS	GRAZIERS
SEPTEMBER, 95	63	4	51
OCTOBER	-	-	-
NOVEMBER	-	-	-
DECEMBER	8	4	-
JANUARY, 96	32	22	-
FEBRUARY	-	-	-
MARCH	-	-	-
APRIL	13	13	-
MAY	22	22	-
JUNE	31	12	-
JULY	41	28	11
AUGUST	24	18	6
TOTAL	234	136	68

Table 11

Source: Checkpost Gatipat, Jiwanal valley

3.4 Monitoring endemic plants

Out of 10,000 taxa (species and sub species) of vascular plants reported from the Himalayan region, nearly 3,500 species are endemic. Of these 200 species are critically endangered (Rawat G.S. 1994). Some of the species that were recorded from the park are given in the table below with their density and abundance. The following sites are suggested for future monitoring.

Table 3.5 : Baseline data on endemic plants

SPECIES	LOCAL NAME	PLACE OF OCCURRENCE	DENSITY/ha	ABUND
<i>Aconitum ferox</i> Wall.	MOHRA	Koberi, Patal, Nada nala, Majhoni	*	*
<i>A. heterophyllum</i> Wall.	PATISH	Tirth, Dhela, Saketi, Raktisar	599.99 ± 13.45	3.42
<i>Angelica gluca</i> Edgew.	CHORA	Rally, Garhandi, Balu, Sakati	350.00 ± 14.36	2.81
<i>Arnebia benthamii</i> Wall.	RATANJOT	Majhoni, Tirth, Raktisar	163.63 ± 72.22	4.15

Abund= Abundance

*didn't occur in sampling plot

3.5 Mushroom monitoring

Mushroom (*Morchella* spp) collection is one of the most important income related activity of the people living around the park. At present *Morchella* is under a great threat due to over exploitation and low rate of regeneration. So as to detect the changes following monitoring plots have been identified and marked in various important areas of collection in the park. The best time for the mushroom is April. Following Table 3.6 is the general guideline for monitoring mushroom.



LOCATION	COLLECTION PRESSURE	WHEN TO MONITOR	HOW	FREQUENCY
Basu PF (T)	High pressure of collection	April 1 st Week	Scanning 20	Once in year
Basu Thach (T)	High pressure zone	April 1 st Week	Do	Once in year
Dhela Thach (S)	No collection	May 1 st Week	Encounter rate in the trail	Once in 2 year
Dulunga Thach (T)	Moderate collection	April 1 st & 4 th	Through scanning the plot	Twice in year
Kanda Thach (S)	Moderate collection	March 4 th Week	Do	Once in year
Ligardi Dhar (S)	High pressure	March 4 th Week	Do	Once in year
Ligardi Thach (S)	High pressure	March 4 th Week & May 1 st Week	Do	Once in year
Mangichal (S)	Moderate collection	April 2 nd Week	Do	Once in year
Mangichal Dhar (S)	Moderate collection	April 2 nd Week	Do	Once in year
Poladal (S)	Moderate collection	April 2 nd Week	Do	Once in year
Rolla Dhar (T)	High pressure zone	April 3 rd Week	Do	Once in year
Silt (T)	High pressure zone	April 3 rd Week	Do	Once in year
Silt dhar (T)	High pressure zone	April 3 rd Week	Do	Once in year

T=Tirthan valley, S=Sainj valley



Table showing location, characteristics and abundance of mushroom in various sites.

LOCAT.= Location, ALTI.=Altitude in metre, SL=Slope percent, CO=Canopy cover, LI=Litter cover in percent, S= Shrubs cover percent, HG=Herbs & Grasses cover percent, GU= Number of *Gucchii* recorded in 20*20 m plot.

LOCAT.	ALTI	AP	SL	CO	LI	S	TREE SPECIES	SHRUBS	HERBS	GRASSES	HG	GU.
Basu PF	2300	N	15	15	15	4	<i>Cedrus deodara</i>	<i>Rosa sericea</i> , <i>Ribes aplestre</i>	<i>Viola odorata</i> , <i>Valeriana jatamansii</i>	<i>Helictotrichon sp</i>	10	4
Basu Thach	2600	SN	5	15	0	8	<i>Picea smithiana</i> , <i>Abies pindrow</i> , <i>Acer caesium</i>	<i>Arundanaria spathiflora</i>	<i>Podophyllum hexandrum</i> , <i>Trillidium govonanium</i> , <i>Eulophia sp</i>	<i>Carex sp</i>	5	2
Dhela Thach	3650	E	12	15	10	10	<i>Quercus semecarpifolia</i>	-	<i>Anemone obtusiloba</i> , <i>Primula sp</i> , <i>Gagea elegans</i>	<i>Kobresia duthie</i>	20	2
Dulunga Thach	2600	S	15	25	40	12	<i>Picea smithiana</i> , <i>Cedrus deodara</i>	<i>Lonicera sp</i> , <i>Sorbaria tomentosa</i>	<i>Chaerophyllum reflexum</i>	<i>Tristem spicatum</i>	20	2
Kanda Thach	2300	SW	20	25	50	5	<i>Picea smithiana</i> , <i>Acer caesium</i>	<i>Indigofera hetrantha</i> , <i>Rosa sericia</i>	-	<i>Carex sp</i>	54	2
Ligardi Dhar	2600	NE	20	15	12	10	<i>Prunus comuta</i> , <i>Abies pindrow</i> , <i>Quercus semecarpifolia</i>	-	<i>Primula denticulata</i>	-	5	1
Ligardi Thach	2400	NE	20	15	15	8	<i>Aesculus indica</i> , <i>Prunus comuta</i>	<i>Cotoneaster affinis</i> , <i>Viburnum nervosum</i>	-	-	0	2
Mangichal	2600	SW	15	10	5	10	<i>Cedrus deodara</i>	<i>Rosa sericia</i> , <i>Indigofera hetrantha</i>	<i>Paris polyphylla</i>	<i>Carex sp</i>	5	1
Mangichal Dhar	2830	SW	20	30	5	6	<i>Ulmus wallichiana</i> , <i>Betula alnoides</i>	<i>Berberis lycium</i>	<i>Gentiana sp</i>	<i>Carex sp</i>	4	3
Poladal	2100	SW	10	15	15	8	<i>Aesculus indica</i>	<i>Sorbaria tomentosa</i>	<i>Iris melesii</i>	<i>Poa alpina</i>	50	2



Rolla Dhar	2150	S	25	20	15	4	<i>Persea duthie</i> , <i>Juglans regia</i> , <i>Aesculus indica</i>	-	<i>Viola odorata</i> , <i>Valeriana jatamansii</i>	<i>Carex foliolosa</i>	12	4
Silt	2800	SE	20	5	5	12	<i>Pinus</i>	<i>Rosa sericia</i>	<i>Primula denticulata</i> ,	<i>Carex</i>	35	4
Silt	2850	SE	15	10	5	11	<i>Rhododendron abrobreum</i> , <i>Pinus wallichiana</i>	<i>Cotoneaster affinis</i>	<i>Viola serpens</i> , <i>Berginia starychei</i> , <i>Gentiana sp</i>	<i>Carex foliosum</i>	25	6

Table 14 : Showing baseline data on total mushroom collection in Tirthan valley during 1994-97 in Kg.

YEAR		1994	1995	1996	1997
MONTH	MARCH	20.250	8.900	17.300	15.500
	APRIL	74.160	80.800	52.450	40.500
	MAY	84.440	32.150	8.00	22.600

For monitoring the amount mushroom harvested from various parts of Tirthan valley during 1996-97 and number of people going for mushroom collection from each village, the following baseline information was collected at entrance points (checkposts) with the help of forest guards and watchers on duty.

Month	# of collectors	# of collectors for each village	Area visited for collection.
MARCH 1997	39	Talinga 3, Manhera Salinga 4, Nanihar 3, Kouncha 15, Nahi 4, Ladecha 1, Dincha 9	Basu, Rikhundi, Kharudhar, Chalocha, Barabasu, Kholeepoi
APRIL 1997	99	Salinga 8, Tinder 35, Sungcha 2, Kouncha 55, Nahi 9, Ghadara 21, Dingcha 18	Rikhundi, Kholeepoi, Basu, Silt, Kharudhar, Rolla, Ladekhol
MAY 1997	62	Tinder 18, Salinga 2, Nahi 2, Kouncha 25, Ghade 2, Manihar 2, Ropa 1, Dingcha 4, Tilinga 6	Kholeepoi, Barabasu, Rolla, Chalocha, Kharudhar, Ladi

REFERENCES

Champion , H.G. and Seth, S.K. 1968

A revised survey of the Forest Types of India. *Government of India Press, New Delhi*

Gaston, A. J. & Pandey, S. 1990.

An Introduction to Biological Monitoring for Protected Areas. *MS, Wildlife Institute of India, Dehra Dun* pp 1-23

Gaston, A.J., Rawat, G.S. & Pandey, S. 1995.

Biological monitoring for Himalayan Ecosystems. *MS, Wildlife Institute of India, Dehra Dun.* Pp 21

Gold Simth, F. B. 1991

Vegetation monitoring. In *monitoring for conservation and ecology*. Chapman & Hall, 77-86.

Michael J. Hutching 1991.

Monitoring plant population census as an aid to conservation. In *monitoring for conservation and ecology*. Chapman & Hall.

Rawat, G.S. 1994

Vegetation monitoring technique. *Manual for conducting protected areas survey and monitoring technique workshop in Bhutan.* pp 33-40.

Rawat, G.S. 1994

Protected areas and conservation of rare, endemic plants in Himalaya. In *High Altitudes of the Himalaya* (Eds Y.P.S. Pangtey & R. S. Rawat) Pp 89-101.

Sykes, J.M. & Horrill, A.D. 1977.

Vegetation Monitoring in Indian Tiger Reserves. A report to world wildlife Fund for nature pp. 1-68.



Appendix 3a: Datasheet for monitoring the abundance of medicinal plant.

The medicinal plants can be monitored in various areas (listed in monitoring sites). Belt transects of 100 m x 2 m are suggested to record the following parameters.

Data collector.....Date.....Year.....

Range..... Block/Beat

Location	Transect 100m X 2 m	Species	No. of individuals	No. of collection signs	% Ground cover (over all)	No. of fruiting individuals

3 b) Data sheet for monitoring medicinal plants at the each checkpost

Collectors name	Village	collected species	Total collection	Area of collection	Remarks